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Introduction

Reading and science are a perfect match — one is enhanced by the other. When reading books with a science theme, children explore exciting new ideas, travel to wonderful places and learn how things work — all of which nurtures their natural curiosity and invites them to engage in science-related activities.

This guide is designed to supplement Reading Rainbow episodes. These activities take advantage of the interplay between science and reading to maximize science learning in the classroom. Integrating science into the curricula through this book-based series will help to foster positive science attitudes.

Opportunities to learn about science are everywhere — and this guide was created to help make the most of these opportunities. Use the episode-specific activities in the days before and after showing the Reading Rainbow program. In this way you will provide students opportunities to explore the science elements of each episode — as well as encourage them to read for discovery and to link reading with action!

Guide Organization

Twenty-eight programs have been designed with science as the primary focus and are designated "science focus" in the upper right corner of the first activity page for those episodes. Thirty-five additional programs have been identified as having science content and science learning opportunities; those are designated "science connected" in the same location. All episodes have from two to eight science activities — each with an informational summary about the activity-related science issue, a list of materials needed and the activity steps.

This guide is dedicated to
Dr. Mary Budd Rowe 1925-1996.

Dr. Rowe was a professor at the
University of Florida at Gainesville
and a visiting professor
Stanford School of Education.

Her support, guidance, and dedication
made the Reading Rainbow science
content strong and relevant.

We miss her.

READING RAINBOW®

Opening Books • Opening Minds

Matrix of Science Concepts

Reading Rainbow Episode Title & Number	Observing Properties	Describing Materials	States of Matter	Movement	Forces	Sound & Vibration	Light Rays	Reflection	Refraction	Absorption	Heat	Electricity	Magnets	Basic Needs of Living Things	Body Structures & Senses	Responses of Living Things	Life Cycles	Animal-Plant Relationships	Behavior & the Environment	Ecosystems
Alejandro's Gift (#113)			●		●							●		●						
And Still the Turtle Watched (#99)														●	●		●			
Archibald Frisby (#115)			●		●															
Best Friends (#43)														●		●				
The Bicycle Man (#68)					●															
The Bionic Bunny Show (#46)					●															
Bored — Nothing to Do! (#64)					●															
Borreguita And The Coyote (#102)	●	●				●														
Bringing The Rain To Kapiti Plain (#4)												●								
Bugs (#47)															●					
Chickens Aren't The Only Ones (#38)	●	●												●			●			
Come A Tide (#86)	●	●	●																	
Desert Giant (#62)														●	●	●				●
Digging Up Dinosaurs (#6)	●														●					
Dive To The Coral Reefs (#61)	●	●												●	●			●	●	●
Duncan And Dolores (#52)					●									●	●					

Reading Rainbow Episode Title & Number	Earth Materials	Physical & Chemical Properties	Soil Properties	Fossils	Sunlight	Changes to Earth's Surface	Weather	Natural Resources	Recycling	Pollution	Safety	Personal Hygiene & Disease	Nutrition	Estimation & Measurement	Classification	Using Simple Instruments	Testing Variables	Explaining with Evidence	Building Models	Observing in the Environment
Alejandro's Gift (#113)	●	●			●														●	
And Still the Turtle Watched (#99)																				●
Archibald Frisby (#115)														●			●			
Best Friends (#43)																				
The Bicycle Man (#68)																			●	
The Bionic Bunny Show (#46)																		●		
Bored — Nothing to Do! (#64)																	●	●	●	
Borreguita And The Coyote (#102)								●									●			
Bringing The Rain To Kapiti Plain (#4)	●	●					●										●		●	
Bugs (#47)														●					●	
Chickens Aren't The Only Ones (#38)															●				●	
Come A Tide (#86)		●					●							●		●	●			●
Desert Giant (#62)																				
Digging Up Dinosaurs (#6)				●										●					●	
Dive To The Coral Reefs (#61)	●	●								●				●					●	
Duncan And Dolores (#52)																				

Matrix of Science Concepts

Reading Rainbow Episode Title & Number	OBSERVING PROPERTIES	DESCRIBING MATERIALS	STATES OF MATTER	MOVEMENT	FORCES	SOUND & VIBRATION	LIGHT RAYS	REFLECTION	REFRACTION	ABSORPTION	HEAT	ELECTRICITY	MAGNETS	BASIC NEEDS OF LIVING THINGS	BODY STRUCTURES & SENSES	RESPONSES OF LIVING THINGS	LIFE CYCLES	ANIMAL-PLANT RELATIONSHIPS	BEHAVIOR & THE ENVIRONMENT	ECOSYSTEMS	EARTH MATERIALS	PHYSICAL & CHEMICAL PROPERTIES	SOIL PROPERTIES	FOSSILS	SUNLIGHT	CHANGES TO EARTH'S SURFACE	WEATHER	NATURAL RESOURCES	RECYCLING	POLLUTION	SAFETY	PERSONAL HYGIENE & DISEASE	NUTRITION	ESTIMATION & MEASUREMENT	CLASSIFICATION	USING SIMPLE INSTRUMENTS	TESTING VARIABLES	EXPLAINING WITH EVIDENCE	BUILDING MODELS	OBSERVING IN THE ENVIRONMENT
Galimoto (#74)	●	●			●																																●		●	
Germs Make Me Sick! (#34)														●																		●	●			●				
Gila Monsters Meet You At The Airport (#8)			●											●	●				●	●	●						●										●			
Gregory, The Terrible Eater (#11)														●													●						●				●			
Hill Of Fire (#23)																					●	●				●													●	
Hot-Air Henry (#16)											●											●					●						●						●	
How To Make An Apple Pie . . . (#118)	●	●												●	●		●			●																				
Humphrey The Lost Whale (#56)														●	●	●			●	●	●	●															●	●		
Imogene's Antlers (#33)	●	●													●																									
Is This A House For Hermit Crab? (#98)														●	●																									●
Jack, The Seal And The Sea (#67)			●								●									●		●		●			●			●										
June 29, 1999 (#100)														●		●			●						●										●					
Kate Shelley & The Midnight Express (#79)			●		●	●																															●		●	
Keep The Lights Burning, Abbie (#37)							●	●	●																															
The Legend Of The Indian Paintbrush (#73)																						●			●		●													
The Life Cycle Of The Honeybee (#36)														●	●				●																●					

Matrix of Science Concepts

Reading Rainbow Episode Title & Number	OBSERVING PROPERTIES	DESCRIBING MATERIALS	STATES OF MATTER	MOVEMENT	FORCES	SOUND & VIBRATION	LIGHT RAYS	REFLECTION	REFRACTION	ABSORPTION	HEAT	ELECTRICITY	MAGNETS	BASIC NEEDS OF LIVING THINGS	BODY STRUCTURES & SENSES	RESPONSES OF LIVING THINGS	LIFE CYCLES	ANIMAL-PLANT RELATIONSHIPS	BEHAVIOR & THE ENVIRONMENT	ECOSYSTEMS	EARTH MATERIALS	PHYSICAL & CHEMICAL PROPERTIES	SOIL PROPERTIES	FOSSILS	SUNLIGHT	CHANGES TO EARTH'S SURFACE	WEATHER	NATURAL RESOURCES	RECYCLING	POLLUTION	SAFETY	PERSONAL HYGIENE & DISEASE	NUTRITION	ESTIMATION & MEASUREMENT	CLASSIFICATION	USING SIMPLE INSTRUMENTS	TESTING VARIABLES	EXPLAINING WITH EVIDENCE	BUILDING MODELS	OBSERVING IN THE ENVIRONMENT
Louis The Fish (#5)														●	●				●		●	●															●		●	
The Magic School Bus ... Earth (#66)																					●	●																	●	●
Mama Don't Allow (#30)				●											●																								●	
The Milk Makers (#32)	●	●												●	●																		●						●	
Mummies Made In Egypt (#54)	●	●	●																			●																		
My Little Island (#45)																					●	●				●								●					●	
My Shadow (#109)							●																		●		●													●
Mystery On The Docks (#19)					●																	●															●		●	
Nosey Mrs. Rat (#101)								●																												●		●		
Once There Was A Tree (#104)														●	●			●			●				●									●						●
Opt: An Illusionary Tale (#76)								●		●					●																							●		
The Paper Crane (#39)	●	●																										●	●	●										
The Patchwork Quilt (#22)	●	●																																			●			
Paul Bunyan (#21)	●	●												●	●	●							●				●													●
The Piggy In The Puddle (#87)																					●	●	●														●			●
Raccoons And Ripe Corn (#77)														●	●			●		●																				●

Matrix of Science Concepts

Reading Rainbow Episode Title & Number	OBSERVING PROPERTIES	DESCRIBING MATERIALS	STATES OF MATTER	MOVEMENT	FORCES	SOUND & VIBRATION	LIGHT RAYS	REFLECTION	REFRACTION	ABSORPTION	HEAT	ELECTRICITY
Rechenka's Eggs (#84)	●	●										
The Salamander Room (#94)												
Sam The Sea Cow (#83)												
Seashore Surprises (#88)						●						
The Shaman's Apprentice (#136)												
Silent Lotus (#95)						●						
Space Case (#31)					●							
Stay Away From The Junkyard! (#57)												
Stellaluna (#108)						●						
Summer (#103)			●								●	
Sunken Treasure (#70)	●	●										●
Tooth-Gnasher Superflash (#63)					●						●	
Ty's One-Man Band (#15)						●						
The Wall (#82)	●	●										
Watch The Stars Come Out (#29)	●	●										

Reading Rainbow Episode Title & Number	MAGNETS	BASIC NEEDS OF LIVING THINGS	BODY STRUCTURES & SENSES	RESPONSES OF LIVING THINGS	LIFE CYCLES	ANIMAL-PLANT RELATIONSHIPS	BEHAVIOR & THE ENVIRONMENT	ECOSYSTEMS	EARTH MATERIALS	PHYSICAL & CHEMICAL PROPERTIES	SOIL PROPERTIES	FOSSILS
Rechenka's Eggs (#84)												
The Salamander Room (#94)		●	●	●				●				
Sam The Sea Cow (#83)		●										
Seashore Surprises (#88)		●	●						●	●		
The Shaman's Apprentice (#136)		●		●	●	●		●				
Silent Lotus (#95)			●									
Space Case (#31)			●			●		●				
Stay Away From The Junkyard! (#57)											●	
Stellaluna (#108)		●	●	●						●		
Summer (#103)		●	●	●			●			●		
Sunken Treasure (#70)									●	●		
Tooth-Gnasher Superflash (#63)												
Ty's One-Man Band (#15)												
The Wall (#82)									●	●		
Watch The Stars Come Out (#29)										●		

Reading Rainbow Episode Title & Number	SUNLIGHT	CHANGES TO EARTH'S SURFACE	WEATHER	NATURAL RESOURCES	RECYCLING	POLLUTION	SAFETY	PERSONAL HYGIENE & DISEASE	NUTRITION	ESTIMATION & MEASUREMENT	CLASSIFICATION	USING SIMPLE INSTRUMENTS	TESTING VARIABLES	EXPLAINING WITH EVIDENCE	BUILDING MODELS	OBSERVING IN THE ENVIRONMENT
Rechenka's Eggs (#84)													●			
The Salamander Room (#94)																●
Sam The Sea Cow (#83)				●		●										
Seashore Surprises (#88)		●								●			●		●	
The Shaman's Apprentice (#136)			●	●												●
Silent Lotus (#95)																
Space Case (#31)																●
Stay Away From The Junkyard! (#57)				●	●	●				●						
Stellaluna (#108)															●	
Summer (#103)			●									●			●	
Sunken Treasure (#70)										●			●			
Tooth-Gnasher Superflash (#63)	●						●									
Ty's One-Man Band (#15)													●		●	
The Wall (#82)		●														
Watch The Stars Come Out (#29)													●	●		

Alejandro's Gift

(GPN #113/PBS #1108)

Author: Richard E. Albert
Illustrator: Sylvia Long
Publisher: Chronicle Books

Science Focused

Program Description: In the feature book, Alejandro's gift was water that he gave to thirsty desert animals. In a desert, water can be difficult to find. Alejandro found it underground using a well. Fortunately for LeVar, when his jeep overheats in this episode, he finds water at an oasis, where he meets with a park naturalist and learns more about the oasis and the native people who once lived there.

Water We Don't See

Key Words: *Water, ground water, well, saturation, water table*

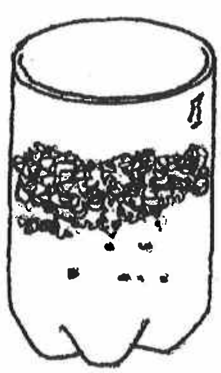
Concept: *Fresh water can be found underground.*

When we think of fresh water, most of us think of rivers and lakes. But less than 1% of all the fresh water on Earth is found in rivers and lakes. Most of the fresh water (75%) is frozen in ice caps and glaciers. The second largest source is one we never see—about 24% of the Earth's fresh water is found underground. A well does not lead down to an underground lake or river but collects and stores ground water.

Materials: Clear 2-liter soda bottle, gravel, water, blue food coloring, pitcher.

1. Cut the top off of a clear 2-liter soda bottle. Fill the bottle with about 6 inches of clean gravel. Imagine that this is a cut-out model of the earth. By looking at the gravel through the sides of the bottle, you can get some ideas about what it is like underground.

2. Use your finger to draw a deep line in the surface of the gravel. This line represents a river bed. The line should be an inch or more deep. Add a bit more gravel to one side of the line to make a small hill.



3. Partially fill a pitcher with water. Add blue food coloring to the water.

4. Slowly pour a cup of the blue water into your river bed. Look at the side of the bottle. What happens to the water? (*It drains down into the gravel.*) This water is like ground water. Look for the top of the ground water. The top of the water is called the water table. Below the water table the gravel is saturated with water. This means that all the tiny spaces between the gravel are filled with water. What will happen to the water table if you pour in more water? (*The water table will rise.*)

5. Slowly pour in more water and wait for it to drain down. Watch what happens to the water table. Keep pouring in more water and waiting until the water table rises up to the level of the river bed. Try to add just enough water so that there is water in the river bed but not up over the hill. Where is most of the water in this model — underground or in the river? (*Underground*) What happens to the water table in a flood? (*The water table rises up above the surface of the land.*)

Well Done

Key Words: *Water, ground water, well, saturation, water table*

Concept: *Ground water can be collected in wells.*

Wells work by collecting ground water which can then be brought up to the surface using a pump or a bucket.

Materials: Bucket filled with 6 inches of gravel, 1-gallon container of water, empty juice can with one end removed, large spoon, knife, toy water pump (optional).

1. Make 2 or 3 rows of 1/2" slits around the bottom of a juice can using a knife. Wiggle the knife a bit to widen the slits.

2. Set a bucket filled with about six inches of gravel in a location where several students can see into it. Make a hole in the gravel that is about 2" across and about 2" deep. Slowly pour water into the hole. Add just enough water so that the water level rises into the hole but does not reach over the top of the gravel. Push gravel back into the hole. Ask students where the water went and where the water is now. (*In the gravel, but below it's surface.*)

3. Let students use a spoon to dig in the gravel so that they can see and feel the water. Tell them this water is like ground water and that wells usually contain ground water.

4. Ask students to dig a hole in the gravel and stand the juice can into it so that the end with the slits is down. Have them push gravel in around the can until the gravel reaches just below the top of the can. Have them predict what might happen. (*Water will drain into the can through the slits in the sides.*)

If you have one available, students can use a toy water pump to pump the water up out of the juice-can well. Allow the water to flow out of the pump and back onto the surface of the gravel where it will drain down through the gravel to become ground water again. Ask them why a well might become dry. (*Because of a decrease in ground water caused by overuse or drought.*)

Tea Time

Key Words: *Water, solvent*

Concept: *Water can dissolve some materials.*

One of the interesting properties of water is that it is a terrific solvent — many things can be dissolved in water. We make use of this property every day when we drink juice, tea, or soda. All of these drinks are mostly water. Each one has different substances dissolved in the water that give it a distinct taste. Long before there were grocery stores, people made their own teas from native plants. They probably soaked the plants in hot water or used the sun to make "sun tea."

Materials: Large glass jar with a lid, water, herbal tea bags, large plastic spoon, drinking cups, sunlight.

1. Fill a large glass jar with cool water. Add 5 or 6 herbal tea bags. Put the lid on the jar and set the jar on a table or shelf in direct sunlight. Be sure to place the jar in a location where it is not likely to be bumped or knocked over.

2. Leave the jar in direct sunlight for several hours and have students describe changes to the water several times during that time.

3. After several hours, move the jar to a table where students are able to see it. Remove the tea bags using a large spoon. Explain that the water has changed color because substances from the tea bags have dissolved into the water.

4. Have students wash their hands and give each a small cup of tea from the jar to taste.

Getting Pushed Around

Key Words: Water, waterfalls, energy
Concept: Falling water is a source of energy.

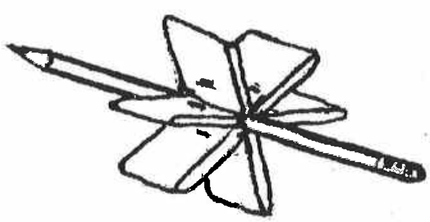
Waterfalls, like Niagara, are a great source of energy. Just by looking at one you can get a feeling for all the power behind that falling water. Waterfalls are used to turn large wheels (turbines) which turn electrical generators. Try using falling water to turn a waterwheel.

Materials: Waxed paper, stapler, pencil, sink or other source of running water.

1. Tear off a 4" wide strip of waxed paper from a roll. Fold the strip in half the long way so that you now have a folded 2 " wide strip of waxed paper.

2. Starting at one end of the strip, fold it back and forth accordion style at 1" intervals until you reach the other end.

3. To make your folded strip into a water wheel, bend the top accordion fold down and around to meet the bottom fold. Overlap these two folds and staple them together. Staple each of the remaining folds closed by placing a staple in each about 1/4" from the bottom. Each accordion fold is now a paddle for your water wheel.

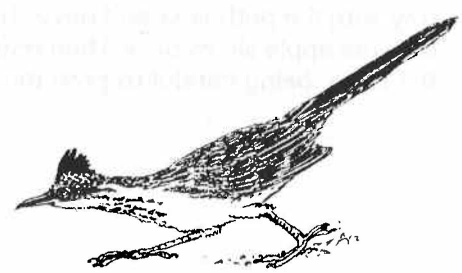


4. Place a pencil in the middle of the wheel. The pencil should fit loosely inside the water wheel so that the wheel can turn easily around it.

5. Holding the two ends of the pencil, move the water wheel under a stream water from a faucet so that just the front paddle touches the water. If your water wheel is working correctly, it should turn so fast that the paddles are a blur of movement. Now if you only had a generator!

Entension: Try making different sizes and kinds of water wheels. Which ones are the best? What happens if the paddles are longer or shorter? What happens if you have fewer or more paddles?

(See *All Dried Up* next page)



All Dried Up

Key Words: *Water, dehydration, evaporation*

Concept: *Water is contained in apples and many other foods.*

All living things need water. But some animals, like the desert kangaroo rat, never drink water. Instead, they get all the water they need from the foods they eat and chemical reactions in their bodies. We can get some idea of how much water is in a food such as an apple by drying some. Drying food is the world's oldest method of food preservation. With most of the water removed, dried foods last longer without rotting, weigh less, and contain virtually all the nutrients of fresh foods.

Materials: Apples, knife, cookie sheet, small covered bowl, oven, potholder, napkins.

1. After having students wash their hands, help them peel and slice several apples. Try to make all the slices the same thickness—about 1/4 inch. Ask students to describe how the slices feel. Explain that the slices feel wet because apples contain water.

2. Have students arrange most of the apple slices on a cookie sheet. Place a few slices in a covered bowl and, if possible, refrigerate these slices.

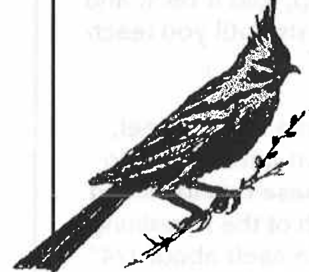
3. Place the remaining apple slices on a cookie sheet in an oven. Set the oven heat for 150° F or at the lowest possible setting. Ask students to predict what the apples will be like after the water has evaporated.

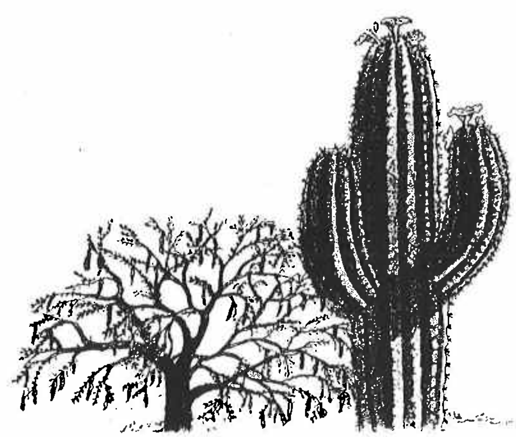
4. So that the moisture evaporating from the apples can escape, leave the oven door ajar about an inch, by closing the door on a folded potholder.

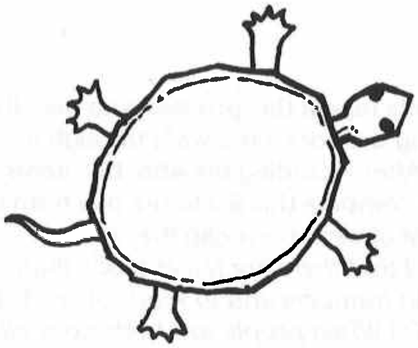
5. The apple slices will be ready in 4 to 6 hours. However you will need to check them about every 30 to 60 minutes. Each time you do, remove the tray with the potholder and have students help turn the apple slices over. Then return the tray to the oven, being careful to prop the door open.

6. When the apple slices are done they will be leathery and soft, and, best of all, ready to eat. Before students eat them, have them compare the appearance and texture of the dried slices to the fresh slices set aside in the covered bowl. Why are the dried slices so much smaller? (*The water has been removed from them.*) Help students notice that the dried slices feel dry and much softer than the fresh slices. This is also because of the lack of water. It is water that gives the fresh apple slices their firm, crisp appearance. Let students compare the taste of both kinds of apple slices. With the water removed, the apple flavor is concentrated in the dried slices.

Extension: Try drying other fruits such as bananas or pineapple.







Science Comes Alive

Science Connected

And Still The Turtle Watched

(GPN # 99)

Author: Sheila MacGill-Callahan
Illustrator: Barry Moser
Publisher: Dial

Program Description: LeVar takes a historical journey from the first settlers in this country to the present, and explores our responsibility to care for the earth. He discovers there are scientists who are caring for the earth by raising nearly extinct bald eagles and releasing them into their natural habitat.

To The Root Of The Problem

Key Words: *plants, roots, root hairs*

Concept: *Root hairs are tiny roots that can be easily damaged.*

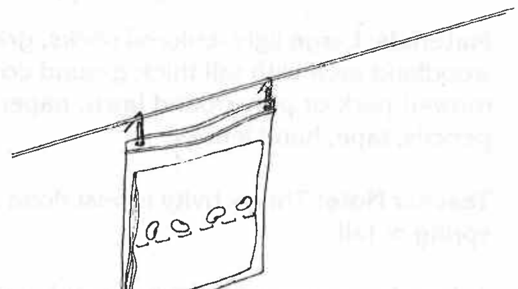
Children in this episode show their concern and respect for the environment by planting a tree. The roots of the tree were wrapped in a large burlap bag. Without this bag to protect the roots, tiny roots called root hairs, would have been broken and damaged during the planting and this would have weakened the tree.

Materials: Bean seeds or other large vegetable or flower seeds that have been soaked in water overnight, self-closing plastic sandwich bags, brown or other colored paper towels (not white), water, stapler, hand lenses, potting soil, clean milk cartons with small drainage holes punched in the bottoms.

1. Have pairs of students place a folded, wet paper towel in a sandwich bag.

2. To hold seeds off the bottom of the bag, help students put a row of staples (about 2" above the bottom of the bag) across the sandwich bag and paper towel.

3. Have them place three or four seeds in their bags, and partially close the bags by pinching them shut in several places. Paperclip the bags along a string or pin them to a bulletin board so that they hang vertically. Have students check the bags every day for about a week, adding water whenever the towel becomes dry. To keep the seeds from molding, pour out any water that is not absorbed by the towel.



4. After about 7-14 days, the seeds will have grown into young plants with roots. Have students look closely at the roots using a hand lens. Point out the tiny root hairs, visible against the colored towel, that are growing from the sides of larger roots. Ask them why they think the root hairs are important. (*Plants take in water and nutrients from the soil through their roots, and these tiny root hairs greatly increase the amount of water and nutrients the plant can absorb.*)

5. Before planting the sprouted seeds, discuss the fragility of the tiny roots and root hairs. Ask students what might happen to a plant if many of the roots were broken. (*The plant would not be able to absorb as much water and nutrients, and could possibly die.*) One method of keeping root hairs and other small roots from breaking is to tie them in a bag of loosely woven natural material, like the tree in this episode. After the tree is planted, the protected roots will grow through the bag into the soil and the bag will decompose. When smaller plants are transplanted, gardeners often leave the existing soil around the roots to protect them.

6. Being careful to protect the roots and root hairs, have students remove the plants from the bags and plant them in milk cartons. Have them continue tending the plants in the classroom and then transplant them into a school or home garden.

Going Along For The Ride

Key Words: *plants, seeds, seed dispersal*

Concept: *Plants have methods of seed dispersal that sometimes do not work in urban environments.*

The tree in this episode and the plants in the ***To The Root Of The Problem*** activity were planted by people. In natural environments, plants usually do not need our help to grow and reproduce, they are dispersed naturally.

Materials: Large light-colored socks, grassy or woodland area with tall thick ground cover, mowed park or playground lawn, paper and pencils, tape, hand lenses.

Teacher Note: This activity is best done in late spring or fall.

1. Locate an area with thick ground cover—such as a meadow with tall grass or a wooded area with brush—that will be safe to lead students through on a short walk. Select a second location that is mowed, such as a school lawn or city park.

2. Ask students to dress in appropriate shoes and long pants for a walk in brush or tall grass. Before setting out, pair students off and have one student in each pair cover a shoe and lower pant leg with a large sock. Take students on a 10–15 minute walk through the area.

3. After the walk have students remove the socks and, together with their partner, examine the items attached to it. Have them make a record of their findings by taping a sample of each item to a sheet of paper and noting the number of each sample found on their sock next to it. What do they think many of these items are? (*Most are probably seeds. Just as they became attached to socks, seeds get attached to the fur of animals and are carried to other places where they fall off and start to grow. This process is called seed dispersal and it's a way seeds are distributed to new places.*)

4. Have students repeat this process with the other partner wearing the sock on a walk through a mowed area. After recording the attached items, have students compare this list to the one from the first walk. What observations can they make? (*They will find that there are fewer seeds than before—both in numbers and in kinds of seeds.*) Why is this so? (*When people use herbicides all but a few kinds of plants are killed and those that do grow are mowed off before they can produce seeds.*)

5. Have students make a list of other possible factors that keep plants from growing and producing seeds in a city. (*Soil is often covered with sidewalks and paved streets so there is less growing space; there are few homes for animals and therefore fewer animals to spread seeds; there is more possibility of air and water pollution which kills plants; the sunlight needed for growth can be blocked by tall buildings; foot or vehicle traffic tramples plants, etc.*)

Science Focused

Archibald Frisby

(GPN #115)

Author: Michael Chesworth
Publisher: Farrar, Straus & Giroux

Program Description: In this episode, LeVar uses several strategies to learn about the roaring and rolling world of an amuse l useful strategies when trying to solve a problem. Problems can come in all shapes and sizes. Here are several activities that come in the shape of popcorn to help you start popping with ideas.

Pops, Flops, And Drops

Key Words: *heat, pressure, boiling, liquid, vapor, steam, phases of matter*

Concept: *Popcorn kernels pop because they contain a tiny amount of water that turns to steam and expands when the popcorn is heated.*

Why does popcorn pop? Why are some popcorn kernels pops and others are flops? The answer to these questions has to do with a tiny amount of water — less than a drop — in each kernel of popcorn. When water is heated to boiling, it expands very quickly as it turns from liquid to steam. When the water inside a kernel of popcorn is heated, the pressure caused by this expansion presses on the hard yellow seed coat of the kernel, causing it to burst open. This is to say, the kernel pops. Test this for yourself.

Materials: Popcorn kernels, cookie sheet, jar with a lid, measuring cup, water, air popcorn popper, two large bowls.

1. Measure out 1/4 cup of popcorn and place it on a cookie sheet. Set the cookie sheet in a warm place, such as by a room heater or in direct sunlight shining through a window. Leave the cookie sheet there through a day and overnight.

2. Measure out another 1/4 cup of popcorn and place it in a jar with 1/2 teaspoon of water. Put the lid on the jar tightly and put it in a cool place overnight. (A refrigerator is good, but any cool place will do.)

3. The next day, pop the popcorn left out on the cookie sheet in an air popper. Separate out the flops-unpopped kernels-and count them. Then, repeat this for the popcorn left overnight in the jar with water.

The popcorn left out in a warm place will dry somewhat, causing some of the kernels to remain unpopped. The popcorn in the jar should have remained moist and so more kernels will pop. Did either pop fluffier? (*The moist popcorn may have.*) It is recommended by popcorn connoisseurs that the kernels be stored in a tightly capped jar in a refrigerator. Can you explain why? (*To keep it from drying out.*) What can you do if you pop part of a package of popcorn and find lots of flops? (*Put the remainder in a jar with a bit of water. The kernels will absorb some of the water and more will pop the next time they are heated.*)

Whose Pops Are Tops?

Key Words: *problem solving, value, test, comparison*

Concept: *Different brands of popcorn vary in taste, appearance and cost.*

What kind of popcorn is best? LeVar seemed to be enjoying the popcorn he was eating. If you were the manager of a concession stand, how would you decide what kind of popcorn to buy and serve to customers? One that is inexpensive? One that is good tasting? You can find an answer to these questions by asking even more questions, and by using your senses.

Materials: Three different brands of popcorn with prices marked on the packaging (if they are the same net weight, comparison is easier), three containers, masking tape, markers, chart paper, small paper cups, pencils, paper, air popcorn popper, 3 large bowls (large clean plastic bags can also be used), napkins.

1. Label each of three large bowls "A," "B," or "C" using masking tape and a marker. Then pop the same amount (about 1/2 cup of each) of three different brands of popcorn and place each brand in one of the labeled bowls (include the flops with the pops.) Keep the popcorn brand names confidential.

2. Tell students they will be testing three brands of popcorn, and will learn the brand of each later. Have them make a record sheet with four columns. Label the columns, in order, "Test," "A," "B," and "C." In the "Test" column, have them write the following four questions: 1) What is the popcorn's appearance? 2) How does the popcorn taste? 3) Did all the kernels pop? 4) How costly is the popcorn? Students can include other questions if they wish. In columns A-C they will record data for their sample groups.

3. Have students wash their hands, then give them popped samples of each popcorn in separate cups. For the first three tests on their record sheets, ask students to give each sample a score from 1 to 3, with 3 being the highest (or best score). For Test 1, students should judge the size and color of the popped kernels. For Test 2, students should judge the flavor of the popcorn. For Test 3, they should evaluate how many of the kernels popped and how many did not.

4. For Test 4, tell students the brand name of each popcorn. Next, determine the price and quantity of each by looking at the packages and prices. Help them determine which brand is most and least expensive (i.e. price per package works if they are all the same size, or compare price per ounce.) Have students score the three brands, giving the most economical brand(s) a score of 3 and the most expensive a score of 1.

5. Have students total their scores for each brand and discuss which brand they feel is the best buy based on data from their record sheet. After the discussion, have students individually write the name of the brand they feel is the best buy on a piece of paper to take with them so they can share the information with an adult at home.

In My Estimation

Key Words: estimation, problem solving

Concept: *Considering estimates made by others improves the final estimate.*

Archibald used the science knowledge he gained from reading books to solve problems. When books aren't available, you can use observations.

Materials: Clear plastic containers with lids able to hold at least 1 cup of unpopped popcorn (peanut butter jar, deli containers, ketchup bottles, etc.), 1/4 cup measuring cups, a box of miscellaneous items (possibly including rulers, bowls, trays, spoons, clear plastic containers, a scale, small measuring cups, craft sticks, and anything else you might think of), paper, pencils.

1. Pour unpopped popcorn kernels into several containers with lids. Vary the amount in each, but do not fill the containers completely. Label each container 1, 2, 3, etc.

2. Give each group of students a container of popcorn, a 1/4 cup measuring cup, paper towels, and a small bowl of unpopped popcorn. Ask them to estimate how many cups of popcorn are in each container using the items you just gave them or any of the items from the box of miscellaneous items. They should not open the containers. Have students record their estimates and methods of estimation on a sheet of paper.

(continued)

In My Estimation *(continued)*

Allow students to be creative in their attempts to estimate the amount of popcorn, but encourage students to get the advice of everyone in the group before making their final estimate. Groups of students who finish before the others can be given the additional challenge of trying to estimate the total amount of popcorn the container could hold if it were full.

3. Ask students to trade containers with another group of students and estimate the amount of popcorn in the new container. Again, have students record their results and methods of estimation. Continue to have students trade containers until each container has been to at least three or more groups.

4. Have students report their estimation for each container. Display and discuss the results. Why might the estimates vary? *(Students will use different methods.)* What different methods were used? Based on the complete set of estimates, what appears to be a good final estimate for each container?

5. Have each group open a container and measure the amount of popcorn using the 1/4 cup measuring cup. After each group has reported the results, discuss which methods of estimation worked best.

A Penny For Your Thoughts

Key Words: *estimation, problem solving, area*

Concept: *Estimates become more accurate with increased experience.*

When using a trial and error approach to solving a problem, the important thing is to learn a bit more about the problem with each trial time and then to keep adjusting the approach based on these findings—just like LeVar kept adjusting his aim each time he tried to bounce the frog onto the lily pad.

Materials: Pennies, nickels, dimes, quarters, unpopped popcorn kernels, overhead projector, marking pens, paper, small cookie cutters, paper, pencils, index cards.

1. Trace around a penny on an overhead projector screen. Remove the penny.

2. Ask students to predict how many unpopped, popcorn kernels will fit inside the circle on the overhead by writing the number on a piece of paper at their desk.

3. Ask a student to fill the circle with kernels as the class counts. (*It will take about 8 kernels.*)

4. Give small groups of students a penny, a nickel, a dime, and a quarter, some drawing paper, and a pencil. Ask each group to predict how many popcorn kernels will fit in a circle made by drawing around each coin.

5. When all the groups are finished, give each some popcorn kernels. Ask them to check their estimates by counting the number of kernels that will fit in each circle. Have the groups report their results and discuss why some of the results may be different. (*Different sized kernels, some students may have allowed kernels to go slightly outside the circle while other groups may have decided that the kernels had to be completely inside the circle.*)

Extension: Trace around several small cookie cutters on index cards. Each day display a different card and have students place their estimates in a box. At the end of the day, count the actual number of kernels that will fit in the shape and give the student(s) with the closest estimate(s) a paper award cut in the same shape as the cookie cutter.

Marble-ous Roller Derby

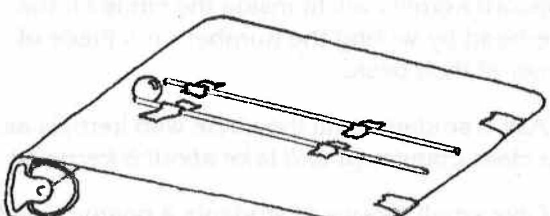
Key Words: *problem solving, measurement*

Concept: *Some problems can be solved using ingenuity.*

Every day is a great day for a Marble-ous Roller Derby. Get your marble pushcarts, imagination, and ingenuity ready. There's the bell. They're off! And if at first you don't win; try, try, redesign, and try again.

Materials: Marbles, 3" x 5" index cards, smooth flat surface, 3" three-ringed binders, straws, tape, ruler, paper, pencils.

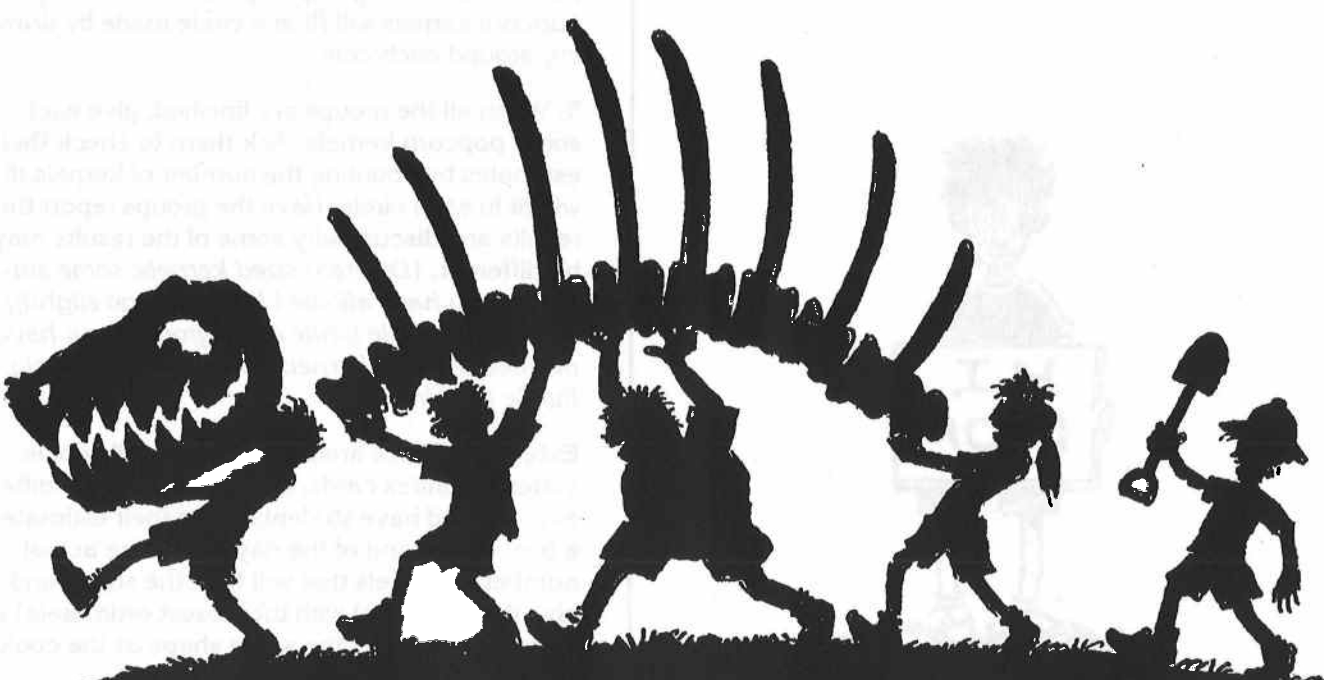
1. Make a marble runway by taping a three-ringed binder closed. Then tape two straws onto the binder as shown, to form guard rails for a marble. Place the marble runway on the floor or other smooth flat surface.

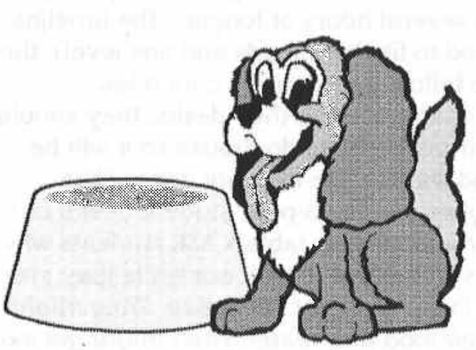


2. Make a pushcart for your marble to push, using an index card. You can fold, cut, tape, or re-shape a single index card in any way you want, but you must use all of the card and your pushcart must be made from only one card. However, you can throw an old card away and start over with a new one if you need to. You can design a pushcart that the marble falls into or behind.

3. Put your pushcart on the floor at the end of the runway. Carefully place a marble on the runway so that it is even with the tops of the straws. Ready, set, let go! Record the distance the pushcart was moved from its starting position using a ruler. Try the same pushcart three times. Record the distance each time and then find the average of the three distances. Make a new pushcart and try it. Make a simple drawing of each pushcart and record their average distances. After you have found the pushcart that you think is best, you may want to arrange a Marble-ous Roller Derby meet. Invite others to design their best pushcart and try to take first place.

Extension: If you find that the Marble-ous roller derby is so much fun that you don't want to stop, try these innovations: change the height of ramp, the angle of ramp, or the size of marble. How does each change impact on the Derby results?





Science Comes Alive
Science Connected

Best Friends

(GPN #43)

Author: Steven Kellogg
Publisher: Dial

Program Description: A pet can be our best friend—and sometimes a helpmate. LeVar learns how seeing-eye dogs are trained to act as eyes for the blind, and meets a young girl who has spent a year raising a dog that will be trained to help a visually impaired person.

Puppy School

Key Words: *dogs, stimulus and response, living things*

Concept: *Animals can be trained to do tasks by using rewards and punishments.*

Puppies are often full of energy. This can make an animal trainer's job difficult, but puppies are also very loving and want to please people. Trainers teach animals to do certain tasks by using rewards and punishments—by smiling and petting a puppy when it does something correctly, and by frowning and tugging at its leash when the puppy does something wrong. In this way puppies learn quickly what their trainers want and don't want them to do.

Materials: Craft sticks, bowls, markers.

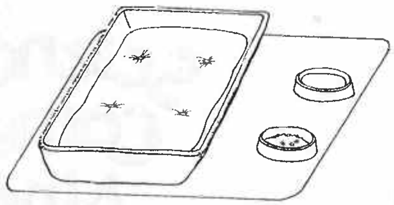
1. Divide the class into three-member teams. Give each team a small bowl containing three craft sticks and ask them to write their names on the sticks with a marker.

2. Tell students that one team member will pretend to be a puppy trainer, another member will be a puppy, and the third member will be an observer. The role of the trainer is to have the puppy follow directions to do a simple task. Trainers can use hand signals (no words or voice clues) to direct the puppy's action. They can also reward the puppy by clapping hands and punish the puppy by shaking a finger; they should not touch the puppy, the sticks, or the bowl. The role of the puppy is to figure out the signals and do what the trainer wants. The role of the observer is to set up the activity and to observe how the trainer and puppy behave during the activity.

3. Ask the puppies to sit in a place out of hearing range while you give instructions to the observers and trainers. Tell the observers to place their team's three sticks in different locations around the room—placing them where they can be easily seen, not under or inside anything. The observer also puts the team's bowl somewhere in the room. As the observers place the objects, the trainers follow their team's observer so they know where their team's three sticks and bowl are located. Tell trainers that their job is to have their puppy retrieve each of their team's three sticks and place them in their team's bowl. Remind the trainers that they cannot talk to the puppies; they can only use hand signals.

4. Ask puppies to rejoin the group. Explain to them that their job is to pay close attention to their trainer and to try their best to follow the trainer's instructions. Puppies are to use their hands, not their mouths, to pick items. Tell the trainers to begin working with the puppies. Remind the observers to watch the trainers and puppies.

5. After about 10 minutes, discuss the following:
- How did the puppies know when they had done something that the trainer wanted? Something the trainer did not want?
- Did it take longer to find the first stick or the last? Why?
- What did the trainers find easy? Difficult?
- How did the observers feel about not being able to give clues?
- How could rewards and punishments be used to train other animals such as circus animals or farm animals?



It's A Dog Day

Key Words: dogs, needs of living things

Concept: Living things kept as pets must have care and attention to their needs.

Puppies like all living things have needs, and as pets they depend on people to help fill those needs. They must be fed, watered, bathed, combed, taken to the veterinarian, provided with a safe and clean home, played with, petted, taken for walks, and cleaned up after. And all of this doesn't need to be done just once; it is an on-going, 24-hour-a-day job. Practice being a pet owner.

Materials: Small clean milk cartons, copies of puppy pattern, copies of puppy rug with basket and dishes, scissors, crayons.

1. Ask students to tell about pets they have (or would like to have) and things that they do (or would need to do) to take care of a pet. Have them help make a list of things pets need such as food, water, shelter, exercise, etc.

2. Tell students that they will be pretending to have a puppy at school. Give each a copy of the puppy pattern and the rug pattern; ask them to color the patterns, and then cut along the double lines and fold along the dashed lines to create their puppy. (Make a stand-up puppy by placing the paper head on top of the body.)

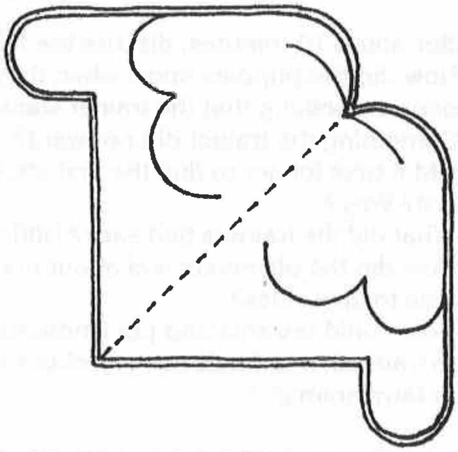
3. Have each student make a doghouse by cutting out one side of a small, clean, milk carton. (Young students may need help with this.)

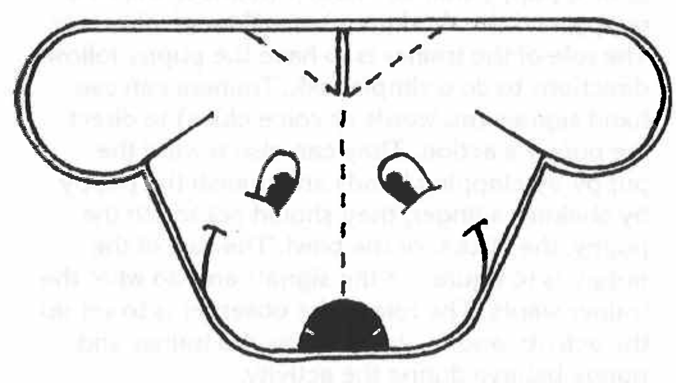
4. Since students will be caring for their puppy at school (for several hours or longer – the timeline can be varied to fit class needs and age level), they will need to follow these puppy care rules:

- Before students leave their desks, they should put their puppy in its doghouse so it will be safe and warm while they are gone. (The doghouses can be kept at student desks or on a classroom shelf or table.) Ask students why puppies should not be left out while they are gone. (*Puppies might run away. They might spill their food and water. They might get too cold or too hot, etc.)*
- When students are at their desks, they should have their puppy out on their rug, either eating or sleeping in the basket. (The rug patterns should be on or near their desks.) Ask students why puppies should not be left in their doghouses once they return to their desks. (*The puppies might get bored and start to bark. The puppies would not get enough exercise. They might get hungry. They need to have some time with people, etc.)*
- While the puppies are sitting out on their rug, students must be careful to leave enough room for them to play. If a puppy is knocked over it should be quickly attended to and set back up.
- In addition to taking care of their puppy, students are still responsible for completing their other school tasks and assignments.

5. After students have cared for their puppies ask them about the experience:

- What was fun about caring for a puppy? What was difficult?
- Did they ever forget to put the puppy in the doghouse or take it out? What would happen if they forgot about a real puppy?
- What other things would they need to do to take care of a real puppy that weren't as important with a pretend puppy?
- In what ways did having a puppy affect their ability to get their other work done?



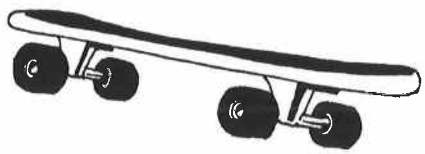


The Bicycle Man

(GPN # 68)

Author: Allen Say
Publisher: Parnassus Press/Houghton Mifflin

Science Connected



Program Description: LeVar explores the world of wheels—from bicycles and skateboards to scooters, rollerblades, and human-powered vehicles. He talks to a free style bike specialist who demonstrates some stunts, and learns about skateboard features from a pro.

(Gyro) Scoping Out The Situation

Key Words: *gyroscopic motion, wheels, gravity*

Concept: *The axis of a spinning wheel tends to stay in the same general positions.*

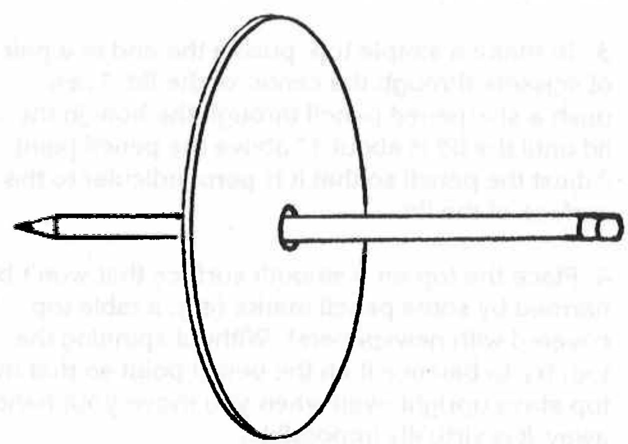
A bicycle is easier to balance when its wheels are on the move. This is because the axis of a rapidly spinning wheel tends to resist tipping from side to side. Small forces such as little pushes, bumps or the pull of gravity will not affect it much. This helps riders, and even trick riders like Woody Ibsen, keep their bicycles balanced. A spinning wheel also helps keep ships at sea and space crafts on a steady course. Many ships have a device called a gyroscope which contains a rapidly spinning wheel. Make a gyroscope and see how it works.

Materials: Lightweight cardboard from cereal boxes or other similar cardboard containers, long round pencils, paper, scissors, a 9" or 10" circular plate.

1. In this activity you need to find the center of a cardboard circle. This is easiest to do by first making a paper circle pattern. Draw a circle on a sheet of paper by tracing around a small plate, then cut out the drawn circle. Fold the paper circle in half, and then in half again to make a shape similar to a piece of pie. Cut off the very tip of this pie shape. When you unfold the shape, there will be a small hole in the center of the circle.

2. Using the paper circle pattern, draw a circle on cardboard and mark its center. Cut out the cardboard circle and push the point of the scissors through the center of the cardboard to create a hole.

3. Push a pencil through the center hole. Move the pencil in a circular motion to widen the hole (about 1/2" in diameter) so that the cardboard circle slips very easily around the pencil.



4. Holding the pencil horizontally with one hand, position the cardboard circle in the middle of the pencil and spin the circle as fast as you can with the other hand. Try tilting the ends of the pencil up and down several degrees. The circle will stay at whatever angle it was at when you started it spinning.

Top Speed

Key Words: *wheels, gravity*

Concept: *A spinning wheel must be turning quickly to stay upright.*

The speed of a spinning wheel is important when trying to hold an object upright. Some of the aerodynamic bikes seen on the show needed a "push start" to help the riders keep the bikes upright until they gained enough speed to stay up on their own. A rapidly spinning wheel can help keep an aerodynamic bike upright, but if the speed of the wheel is not great enough the bike becomes harder to balance and the force of gravity will pull it down.

Materials: Plastic lids (from margarine tubs, whipped topping, or other similar containers), pencils, a smooth surface, newspapers (optional).

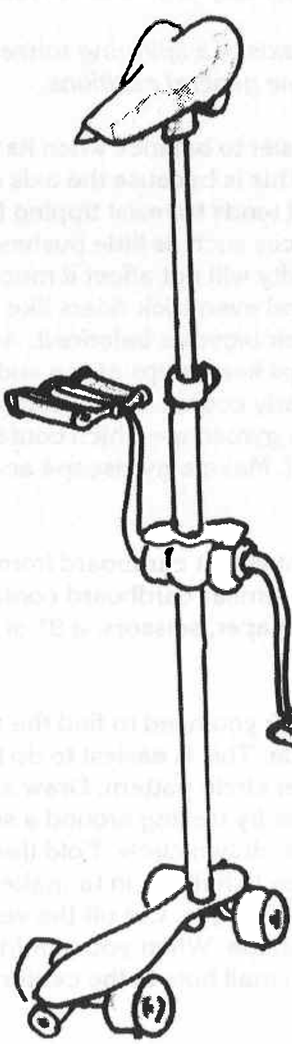
1. Stand a plastic lid up on edge with your finger on the top. Then push the lid so that it rolls across the floor. What happens when it slows down? (*It falls over.*)

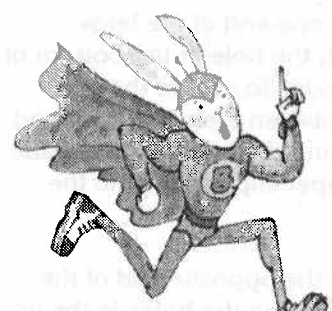
2. Next find the center of the lid. Plastic lids usually have a small raised point at the center. If there isn't one, then use a ruler to measure halfway across the lid at its widest point.

3. To make a simple top, push a the end of a pair of scissors through the center of the lid. Then push a sharpened pencil through the hole in the lid until the lid is about 1" above the pencil point. Adjust the pencil so that it is perpendicular to the surface of the lid.

4. Place the top on a smooth surface that won't be harmed by some pencil marks (e.g. a table top covered with newspapers). Without spinning the top, try to balance it on the pencil point so that the top stays upright even when you move your hand away. It is virtually impossible!

5. Now try spinning the top on the pencil point as fast as you can. What happens when it slows down? (*It falls down.*) When does the top stay standing up and when does it fall down? (*The top stays up when it is spinning rapidly. It falls down when it begins to slow down.*)





The Bionic Bunny Show

(GPN #46)

Science Connected

Author: Marc Brown & Laurene Krasny Brown
Publisher: Little, Brown

Program Description: In a visit to the taping of *Star Trek: The Next Generation,* LeVar shares a behind-the-scenes look at how another television show, where he is a character named Lt. Geordi LeForge, is made. Experts from the show explain how they create special effects and how the show is edited.

Seeing Is Believing

Key Words: vision, visual illusions, making observations

Concept: What we see can be explained.

We rely heavily on our sense of sight to receive information about the world around us. Movie magic like the models and computer-generated images shown on *Star Trek: The Next Generation* are examples of our tendency to believe what we see. Magicians use this tendency to their advantage when they show us things we know can't be real. Try creating a visual illusion.

Materials: Quarters, dimes.

1. Have a small group of students practice the following visual illusion:
   - Place a dime on the inside of the fingers of your left hand. Cover the dime with a quarter. Then place a second dime on top of the quarter.
   - Hold your left hand out flat to show the dime resting on the quarter. (Be sure the lower dime is completely covered by the quarter.) Then take the top dime off the quarter and place it in your pocket using your right hand.
   - Close your left hand, folding your fingers over your palm to flip the quarter and lower dime over onto your palm. (The lower dime will now be on top of the quarter.)
   - With your left hand still closed, tell those watching that you will make the dime reappear on top of the quarter. Wave your right hand and pretend to throw an invisible dime at your closed left hand.
   - Open your left hand and show that the dime is resting on the quarter.

2. After the students have practiced the above steps, have them perform the illusion in front of a small group of students who have not seen the illusion. Have the observing students ask the performer questions and/or work with coins until they discover how the illusion was created.

3. Ask the observing students what they thought when they first saw the illusion, why they didn't believe the illusion was real, and how they came up with an explanation for the illusion.

Science Note: Scientists use a similar process in their research. If scientists see something they don't understand, they begin looking for a scientific explanation based on principles of physics, biology, and/or other sciences. Some of the ways they do this is by talking to people about their questions, reading about the subject, and performing experiments related to the observation. Scientists have a basic assumption that events can be explained—that they are not "magic."

Rolling Along

Key Words: scientific inquiry, observation, experimentation

Concept: Events can be explained.

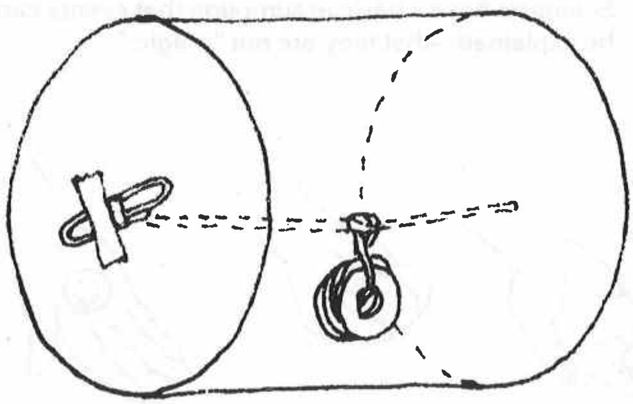
A basic assumption of science is that events can be explained. Scientific inquiry is the process of using principles of science to explain how or why events happen. It includes the task of trying to separate fact from fiction, which can be difficult because, as was observed in the ***Seeing Is Believing*** activity, events are not always what they appear to be. Initial explanations sometimes turn out to be more fiction than fact, but through continued observations and experimentation the correct explanation can often be discovered.

Materials: Coffee can with a plastic lid, stiff cardboard, hammer, nail, small rubber band, large rubber band, paper clips, heavy metal washers, tape, wrapping paper.

1. Follow these steps to make a "rollback can" ahead of time, so students are not aware of how the can is made.

- Trace around a plastic coffee-can lid to make a circle the same size as the lid. Cut out the circle and tape it on the top of the lid to add rigidity. Using a nail, punch a hole through the center of the plastic lid and through the cardboard circle. Punch a similar hole in the bottom center of the coffee can.

- Thread several heavy washers onto a small rubber band, and then tie the rubber band in a knot around the washers. Tie this to the center of a large rubber band.



- Use the nail to push one end of the large rubber band through the hole in the bottom of the can from the inside. To secure the end, push a paper clip between the protruding end of the rubber band and the coffee can outside bottom. Tape the paper clip securely to the bottom of the can.

- Use the nail to push the opposite end of the large rubber band through the holes in the lid and cardboard from the inside. To secure this end, push a paper clip between the end of the rubber band and the cardboard, then tape the paper clip to the cardboard. Place the lid on the can. The large rubber band should now be suspended horizontally with the small rubber band near the center of the can hanging down vertically. The washers should not be touching the side of the can.

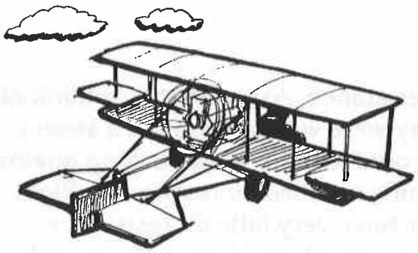
- Test the can by gently rolling it forward. The can should roll forward and stop, winding up the large rubber band as it goes. Then the can will roll back towards you as the rubber band unwinds. If the can does not roll back, you may need to add additional washers or try a rubber band that is tighter or looser.

- Cover the can with wrapping paper keeping it as smooth as possible so that it will roll easily. Now your rollback can is complete.

2. Demonstrate the rollback can for the class. Without unwrapping it, ask them to develop an explanation of how the can works. Have them work in small groups to brainstorm explanations. If they have difficulty, you may wish to give them a list of the materials you used to make the rollback can.

3. Have each group of students present drawings of their ideas. Discuss which ideas the class feels would work and which would not and why. Ask students how they might revise their ideas after the class discussion. Ask them to see how many of their ideas are physical explanations rather than magical ones.

Extension: Assist students in collecting materials to build a model demonstrating their idea. After discussing a construction plan, have them build the model and test it, revising it as they work. They will undoubtedly want to unwrap the demonstration can, but encourage them to modify their models as they continue observing how the demonstration can works.



Bored— Nothing To Do!

(GPN # 64)

Author: Peter Spier
Publisher: Doubleday

Science Connected

Program Description: On a commercial airline flight, LeVar finds out that airline employees do everything—from stocking up on meals and stowing luggage to flying the plane and caring for the passengers. He also flies a remote control model airplane, explores the history of flight through film clips, and gets a chance to pilot a plane himself.

The Plane Truth

Key Words: airplanes, wings, lift, airfoil, air pressure, Bernoulli's principle

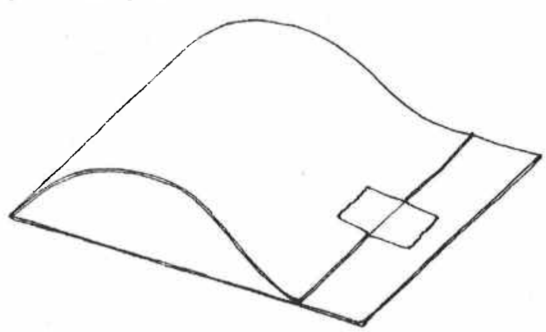
Concept: Airplanes have wings shaped like airfoils—which give them lift and help them fly.

When LeVar flew the plane, he seemed very excited and a little nervous. The idea of getting a heavy plane off the ground and keeping it in the air seems magical, but it can all be explained through the study of aerodynamics. An important concept of air flight is lift. Lift is the upward force caused by the motion of airplane wings through the air. Lift is what holds an airplane up while gravity is pulling down on it.

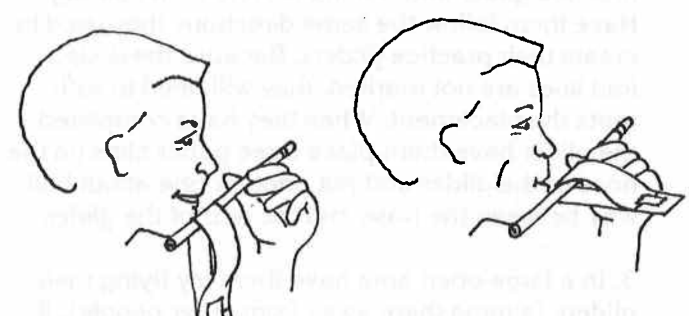
Materials: Typing paper, scissors, tape, pencils.

1. Have each student cut a 2" x 6" strip of paper.

2. Ask students to fold their strip in half so it becomes a 2" x 3" strip. Have them push back the top edge about 1/2" and tape it there. This shape, which is flat on the bottom and rounded on the top, is called an airfoil. It is the shape of airplane wings.



3. Have students place a pencil through their airfoil so that the taped end is hanging down with the flat side of the airfoil toward them. Tell them to hold it about 1" from their mouth and blow out and over the curved part of the airfoil. As they blow steadily across the top of the airfoil, it will pivot up. They might need to try this several times before it works. (*The upward force produced by the moving air over the airfoil is called lift. Lift is what holds an airplane up against the force of gravity. When students blow across the top of the airfoil, the air pressure on the top of the airfoil becomes less than the air pressure underneath it. The airfoil is actually pushed up by the greater air pressure underneath it.*)



4. To demonstrate that they aren't just blowing the airfoil up, have students try it again with the curved side of the airfoil toward them. They will see that, no matter how they blow, they aren't able to get the airfoil to rise.

The Wright Way To Fly

***Key Words:** airplanes, air resistance, drag, ailerons*

***Concept:** Air resistance, or drag, can change the way an airplane flies.*

Early flyers, like those shown in this episode, knew a bit about lift and how to get an aircraft into the air. What they really struggled with, and what the famous Wright brothers finally began to understand, was how to control an aircraft once it was in the air. One of the forces they learned to control was air resistance, or drag. Build a paper glider and learn how drag can change its flight.

Materials: Copies of the glider pattern, sheets of oak tag, pencils, scissors, paper clips, a gym or other large open area free from wind

1. Give students a glider pattern and have them follow these steps to make a practice glider:
   - Cut along the double lines of the glider pattern including the wing flaps—but do not fold them
   - Fold the glider in half along the center dotted line
   - Create the wings by folding down the dotted lines on both sides of the centerline.
   - Fold up on the dotted line near the end of each wing to create the wing tips.

2. Now that they are familiar with the process, have students make gliders by unfolding the practice glider and tracing around it on oak tag. Have them follow the same directions they used to create their practice gliders. Because the dotted fold lines are not marked, they will need to estimate the placement. When they have completed the glider have them place three paper clips on the nose of the glider and put another one about half way between the nose and the rear of the glider.

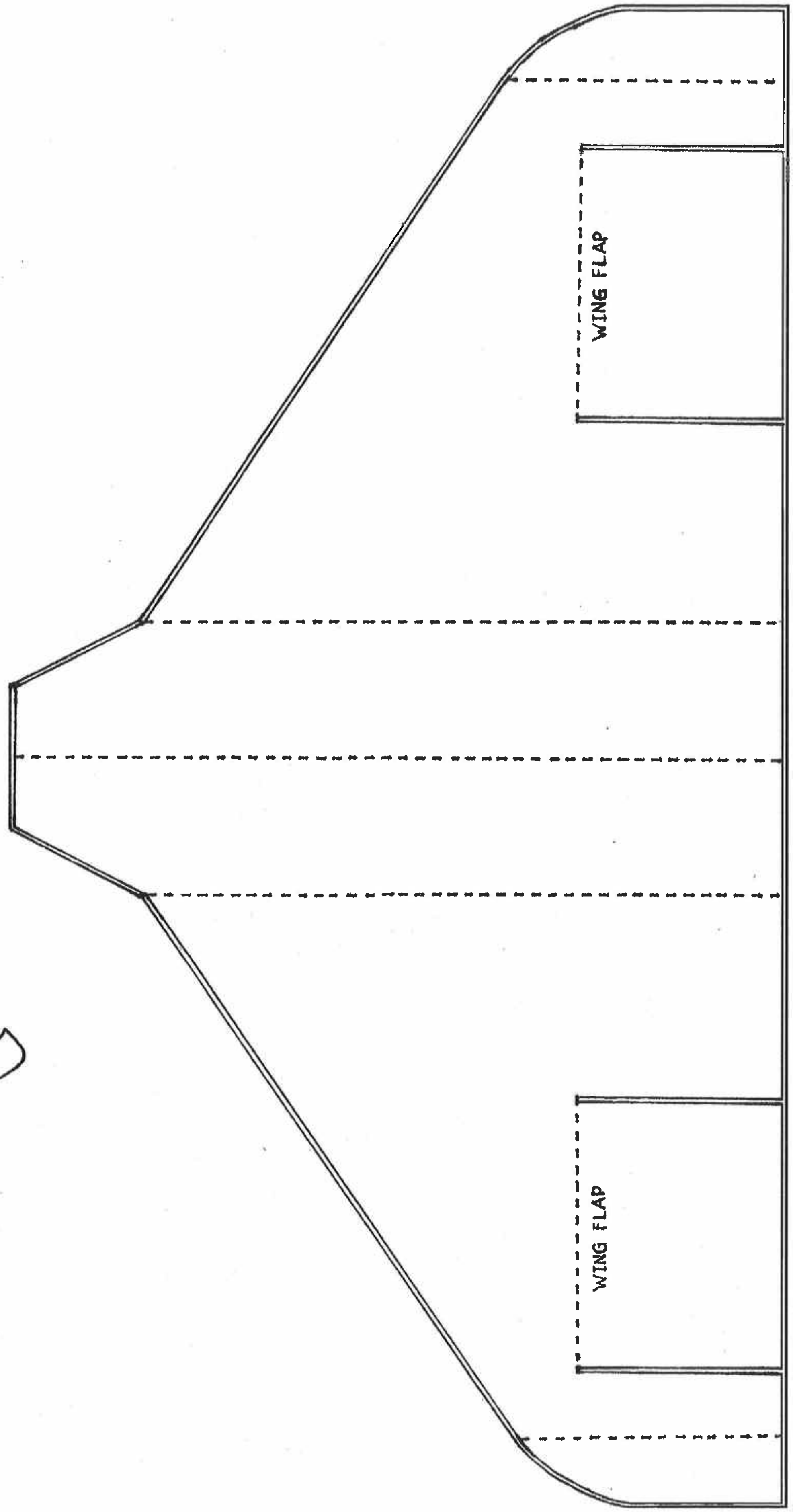
3. In a large open area have them try flying their gliders (aiming them away from other people). If they throw their glider with a smooth, even, slightly upward push, it should fly in a fairly straight path.

4. Discuss air resistance. Ask students to think of a time when they were walking against a strong wind and they could feel the wind pushing against them. This pushing is called air resistance. Right now their gliders have very little air resistance because there are few places for the air to push against.

5. Have students turn up one of the wing flaps, called an aileron. (LeVar and the flight instructor checked these on their airplane during their preflight inspection.) Explain that the air will push on the upturned aileron creating some air resistance or drag. Have students predict how this will change the flight path of their gliders. (*It will cause them to turn to the left or the right, towards whichever side has the aileron turned up.*)

6. Have students test their predictions by flying the gliders and discussing any changes that they observe. Then have them fold the aileron back flat and fold the other one up. Again ask them to predict what will happen, then try flying it.

7. Finally have students fly them with both ailerons turned up. (*The gliders will tend to fly up, stall, and then fall down.*) Have them try turning both down. (*The gliders will dive towards the ground.*) Each time have students make predictions and then discuss their observations. (*Students shouldn't be discouraged if their glider doesn't fly as expected every time. Just as the Wright brothers learned, it's very difficult to control all the factors involved in flight.*)


WING FLAP
WING FLAP

Borreguita And The Coyote

(GPN # 102)

Author: Verna Aardema
Illustrator: Petra Mathers
Publisher: Knopf

Science Comes Alive
Science Connected

Program Description: LeVar experiences Mexican American culture when he spends time with a family who has made guitars for three generations, visits a mural painter and her students who are working on self portraits, and joins Los Lobos as they share their music and cultural ties.

Sounds Good

Key Words: *guitars, sound, vibrations*

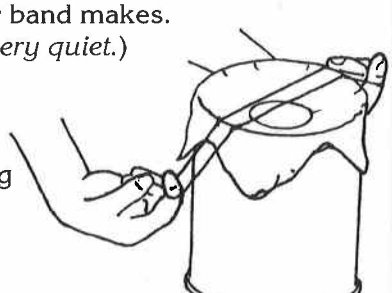
Concept: *The body of a guitar increases the sound made by the strings.*

The Delgado family, three generations of guitar makers visited in this episode, know that making a guitar is an art form and a science. Their guitars not only look beautiful but also produce beautiful music. To create a guitar that makes a beautiful sound, they must apply physical properties of sound when making it. Experiment with a stringed instrument to learn how to improve its sound quality.

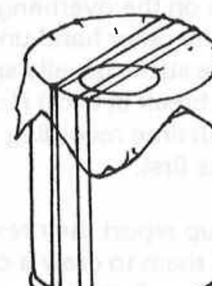
Materials: Small coffee cans, medium-sized rubber bands, aluminum foil.

1. Have pairs of students place a sheet of aluminum foil over the top of an empty coffee can. Place the foil so that it makes a shallow bowl shape in the top of the can. Then have them use a table knife to cut a 2" round hole in the center of the foil.

2. Have one of the students stretch a rubber band between their index fingers and ask the other to strum across the rubber band. Have them describe the sound the rubber band makes. (*The sound will be very quiet.*) Remind them that sounds are caused by vibrations. Ask them what is vibrating to cause this sound. (*The rubber band.*)



3. Have students repeat the strumming; however, this time holding the stretched rubber band across the top of the coffee can. Ask them to describe how the sound has changed. (*The sound will be much louder.*) Have them repeat strumming the rubber band in each way, observing the difference in sound. Why do they think the sound is louder when it is strummed across the can? (*The sound of the vibrating rubber band is louder on the coffee can because the rubber band is now causing the air inside the can to vibrate as well.*)



4. Have them make a simple instrument similar to a guitar by stretching several rubber bands around the coffee can from top to bottom. After they've had some time to strum their instruments, discuss the guitar segment from this episode. Ask them to describe how their instrument is similar to the guitar. (*Both have strings, a base or body that supports the strings, and an air-filled part that amplifies the sound.*) Ask them to describe how a real guitar would sound if it did not have a base or body, just strings. (*It would sound much quieter, like the rubber bands before they were placed on the coffee can.*)

Looks Good

Key Words: *guitars, wood, observable characteristics, making comparisons, drawing conclusions*

Concept: *Wood is more bendable if it is wet.*

In addition to knowing about the physics of sound, the Delgado family must be very knowledgeable about the properties of wood. They use special woodworking techniques of veneer, inlay, and wood bending to make guitars. The technique of wood bending is very important to any guitar maker since the curved sides of a guitar are made by bending thin pieces of wood. A guitar with straight sides just wouldn't sound the same. Try bending wood.

Materials: Craft sticks, dishes of warm water, sturdy tables or countertops, paper and pencil.

1. Have small groups of students place 6 craft sticks in a dish of warm water to soak for about 5 minutes.

2. Have a student from each group place a dry stick and a wet stick side-by-side on a table or countertop with the sticks hanging about 3 inches over the edge of the table. Holding the sticks in place with the palm of one hand, ask them to slowly push down on the overhanging stick ends with the palm of the other hand until one of the sticks cracks. (The sticks usually splinter and crack rather than break in two.) Have students try this six times, each time recording whether the wet or dry stick breaks first.

3. Have each group report their results and, based on their data, ask them to draw a conclusion as to whether dry or wet craft sticks are more bendable. *(Wet ones are more bendable. Woodworkers usually steam wood before trying to bend it because steaming wood softens the bonds between the wood cells allowing the wood to be bent more easily.)* Based on what they've observed, ask students why a freshly cut twig is usually more bendable than one that was cut several weeks ago. (*The fresh twig will contain more water than the twig that was cut several weeks ago.*) Ask students why it is important that wood in living trees be bendable. (*If the wood did not bend it would be broken by the force of the wind and the weight of ice.*)

Bringing The Rain To Kapiti Plain

(GPN # 4)

Author: Verna Aardema
Illustrator: Beatriz Vidal
Publisher: Dial

Science Connected

Program Description: LeVar gets involved in rainy day activities including chasing a thunderstorm and puddle-hopping. At the National Center for Atmospheric Research experts share information about predicting weather and meteorology, and tell about occupations linked to the study of weather.

One Drop At A Time

Key Words: water, water drops, surface tension/ adhesion

Concept: Water sticks to itself.

Raindrops, like those outside LeVar's window in this episode, form droplets because water sticks to itself, or more precisely because water molecules stick to each other.

Materials: Paper towels, eye droppers, water, cups, small objects such as pennies, nickels, dimes, metal washers, paper circles, metal spoons, plastic spoons.

1. Have groups of students place a penny on a paper towel and give them an eyedropper, and a cup of water. Ask them to think about how many water drops they can put on the penny before it "floods" onto the paper towel. Have each student estimate the number and not share it with anyone else.

2. Have each group member take turns putting drops on the penny, three at a time—trying to avoid being the one to have a "flood." Ask all group members to keep track of the total number of drops. After the "flood" have them compare their written estimates to see whose was the closest.

3. Ask students to describe how the water looked on top of the penny just before the "flood." (*Water piles up on top of the penny like a dome and stays there because water sticks to itself. Finally, when there is too much water, it overflows. The stickiness of water is what holds the water in raindrops.*)

4. The student with the closest guess can have the first turn with the eyedropper as the groups continue this exploration by placing water drops on other objects such as a nickel, a dime, a metal washer, a paper circle the size of a penny, the back of a metal spoon. Remind them to count the number of drops, and to compile a list of objects with the number of drops each held.

Snap, Crackle, Zap

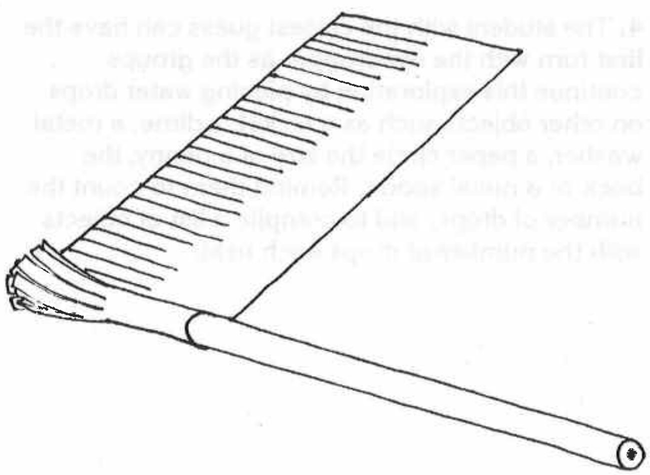
Key Words: *thunderstorms, thunder, lightning, static electricity*

Concept: *Thunder is caused by static electricity.*

Children in this episode describe thunder as the sound of bowling and moving furniture. Actually thunder is caused by rapidly expanding air that has been super-heated by lightning. Lightning is caused by an electrical discharge from clouds. Experience thunder and lightning on a miniature scale.

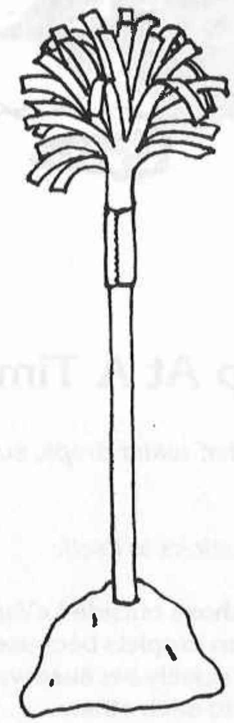
Materials: 10" x 2" strips of tissue paper (green, if possible), scissors, pencils, modeling clay, table, inflated balloons (black, if possible), wool or polyester cloth.

1. Make a fringed edge on the tissue paper strips by having students cut narrow tabs all the way down one of the 10" sides of the paper. The tabs should be about 1/4" apart and about 1" deep.



2. Students can make a model of a tree by wrapping the tissue paper strip around the end of a pencil. The fringed edge of the paper should be above the top of the pencil. Have them secure the paper with tape and then fluff apart the fringes to make branches for the tree.

3. Have each student press a lump of clay on a tabletop and stand the tree model up in the clay.



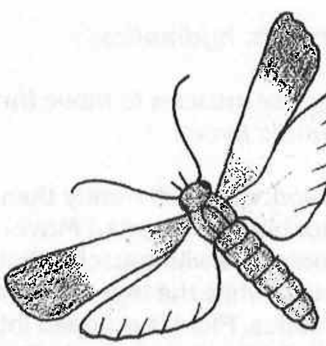
4. To make a model of a thundercloud, have them rub an inflated black balloon on wool or polyester cloth, or on their own hair. This will generate a static electrical charge on the balloon similar to the charge present in thunderclouds.

5. Have them hold the thundercloud over the tree. As the cloud gets closer to the tree, the branches will begin to move as they are attracted to the static electrical charge of the cloud. As they move the cloud even closer, it will begin to discharge the static electricity to the tree. Have students listen closely. (*They will hear tiny crackle sounds. This is the sound of thunder on a tiny scale.*) Have them repeat this until everyone has been able to hear the thunder. Why do they think it is not wise to take cover from a thunderstorm under a tree? *(The tree provides a point of discharge for the static electricity in the cloud. As the static electrical discharge moves through the tree, it can also move through things near the tree.)*

Extension: Have students try this in a darkened room or closet. Tell them to watch the balloon just above the tree as it is discharging static electricity. They will be able to see small sparks—lightning!

Bugs

(GPN # 47)



Author: Nancy Winslow Parker
and Joan Richards Wright
Illustrator: Nancy Winslow Parker
Publisher: Greenwillow

Program Description: Insects and spiders are everywhere. Although many people refer to all of them as bugs, bugs are a subgroup of insects. In this program we get a look at some unusual insects when we join LeVar at the Cincinnati Zoo's Insect World. We then travel to the Sierra Cinqui Mountains in Mexico to learn about the winter migration of monarch butterflies.

Making Census Of It All

Key Words: population, estimate, average, sample

Concept: Population sizes can be estimated using a sampling method.

Scientists estimate the population of an animal group (e.g. monarch butterflies, mice, fish) by using a sampling method. They catch and tag a few of the specified animals, then release them. Later, to measure the population, scientists catch some of the animals and count how many of the group have been tagged. By repeating this process several times and averaging the numbers, scientists can closely estimate the population of an animal group.

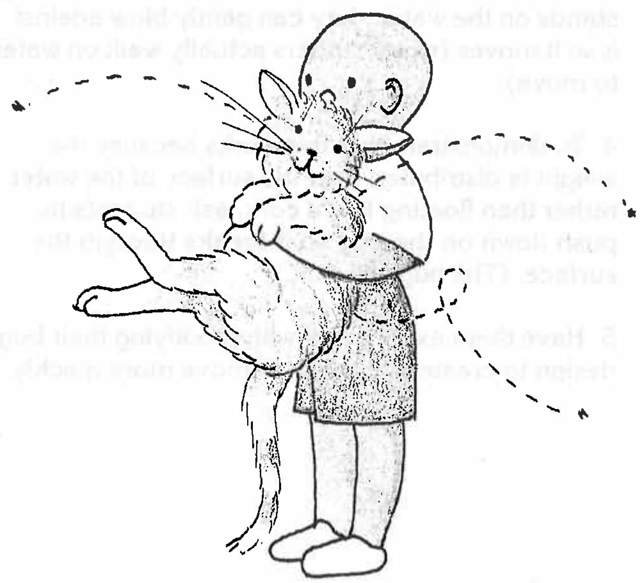
Materials: Paper-punch dots, envelope, writing paper, pencils.

1. Start with a large number of paper-punch dots (approximately 75-100 — but do not count them). Count out 10 and mark them with an "x". Put all the dots in an envelope and mix them up.

2. After they are mixed well, pinch a sample of 10-15 dots. Count and record the total number of dots in the sample and the number of marked dots. Divide the original number of marked dots (10) by the number of marked dots found in this sample.

3. Multiply the total number of dots in the sample by the result of the division in step 2. The product is an estimate of the total number of dots in the envelope. Example: Suppose 16 dots were in the sample and 2 of them were marked. You would divide 10 by 2 = 5. Then multiply 16 (the sample size) by 5. The total number of dots is estimated at 80.

4. Repeat steps 2-3 several times. For a more accurate estimate, average these samples.



Fun Bugs

Key Words: *insect, bug, spider, characteristics, classification*

Concept: *Different kinds of insects have specific characteristics by which they are classified.*

While people often talk about any insect or spider as a bug, scientists who study insects (entomologists) use the term bug to describe only one group of insects. All insect classes (i.e. butterflies, beetles, dragonflies and bugs) have certain characteristics which determine their classification — for bugs it's their short wings.

Water striders (*Gerris remigis*) are true bugs which can actually walk on water. They are heavier than water but because they spread their weight out over their six long legs, they do not break through the surface of the water.

Materials: Aluminum foil about 2" (5cm) square, saucers of water, scissors.

1. Give each group a saucer of water, and one square of aluminum foil for each student.

2. Review the body structure of insects — head, thorax with legs attached, and abdomen. Then have each student cut a six-legged bug out of the foil square and shape it so the bug stands with its feet flat on the table or desk.

3. Tell students to place their bugs in the dish with their feet flat on the surface of the water (the abdomen should not touch the water). As the bug stands on the water, they can gently blow against it so it moves (water striders actually walk on water to move).

4. To demonstrate that this works because the weight is distributed over the surface of the water rather than floating like a cork, ask students to push down on the bug so it breaks through the surface. (The bug will sink.)

5. Have them experiment with modifying their bug design to create one that can move more quickly.

Daddy Longlegs

Key Words: *spiders, insects, hydraulics*

Concept: *While insects use muscles to move their legs, spiders use hydraulic forces.*

The bodies of spiders work quite differently than insects. (Spiders are not bugs or insects.) Movements of insects are controlled with muscles that work something like ours, while the legs of spiders are controlled by hydraulics. Fluid is pumped into the leg of a spider to straighten it and elastic fibers bend the leg when the fluid flows back out. (This is why spiders curl up when they die.) Make this model to see how spider legs work.

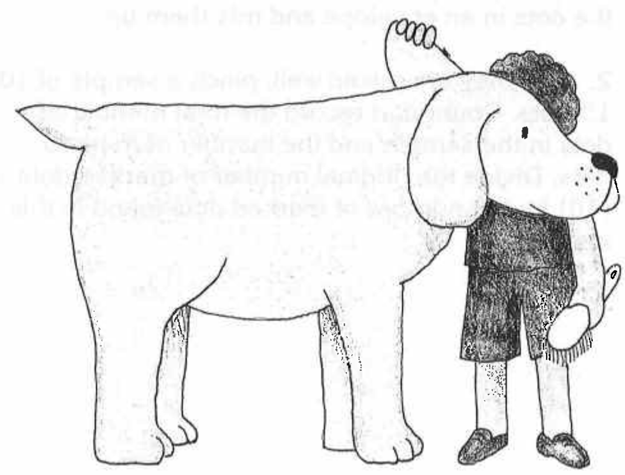
Materials: Straws, scissors, thin balloons (the ones used to make balloon animals work well).

1. Cut two pieces from a straw - one 4" (10cm) and one 2" (5cm). Fold a pipe cleaner in half so the ends are together; then thread 3" (7.5cm) of a balloon over the bent end of the pipe cleaner.

2. Push the balloon-covered pipe cleaner through the short straw piece and then into the longer piece. Make sure the open end of the balloon is not pushed into the straw.

3. To remove the pipe cleaner and make sure the balloon stays in place, pinch the straw to hold the far end of the balloon then pull out the pipe cleaner.

4. Hold the short straw piece and blow into the balloon to make the model leg kick. The air going into the balloon simulates the fluid that moves the spider's leg.



Chickens Aren't The Only Ones

(GPN # 38)

Author: Ruth Heller
Publisher: Grosset & Dunlap

Science Focused

Program Description: Which came first, the chicken or the egg? In this program, LeVar visits a chicken farm and provides us with "eggsclusive" information about how baby chicks are kept safe until their final moment of hatching. He also travels to the beaches of Melbourne, Florida, to watch loggerhead turtles emerging from the ocean to bury their eggs in the sand.

Nestling In

Key Words: *egg, egg-laying animal, classify, category*

Concept: *Animals can be classified in many different ways.*

Use this to stimulate thinking about egg-laying animals.

Materials: Egg-shaped pieces of paper, pencils.

1. On egg-shaped pieces of paper, ask students to write the name of an animal that hatched from an egg.

2. Break the class into groups of 5-6, and have them find ways to classify their animal-labeled eggs. After they've finished, ask a representative from each group to report the number and names of the categories they created. Then have them return to their groups and reclassify the animals by choosing new categories — changing the number of categories they use. For example, a group who used two categories (e.g. land & water) for the first time, can use three (e.g. fins, fur and feathers) for the second.

3. Finally, have groups trade eggs to classify.

The Fun-Nest Bulletin Board

Key Words: *classification, pictograph*

Concept: *Animals can be put in groups based on a classification system.*

Materials: Brown butcher or bulletin board paper, scissors, marker pen.

Use the eggs created and the classification skills practiced in ***Nestling In*** to help create an interactive bulletin board.

Create a nest out of paper that will cover the bottom of a bulletin board.

Choose one system of classification that works for the eggs created in ***Nestling In*** (e.g. mammals-birds-reptiles-amphibians-fish or swim-fly-walk-crawl-slither). Label areas of the nest with these categories.

Let students work together to place their egg near the label that best describes their animal.

This can be turned into a graphing activity by simply stacking the eggs in a line over the labels to make a pictograph. Students can also use the information on the board to make a bar graph.

In the days to come, students can expand the information on the bulletin board by doing research on each animal and adding facts to the egg (have them turn the egg over to write the animal's name and the fact on the back). Challenge students to continue until every egg has been turned over.

“Eggs-amination”

Key Words: *egg, shell, yolk, white, air sac, germ spot, chalaza, shell membrane*

Concept: *Eggs are composed of different parts that have specific functions. Take a closer look at a chicken egg.*

After discussing eggs and chicks (see the following questions and use the illustration to help identify the elements of an egg), break an egg to have a closer look. Discuss the functions of the shell which protects the egg from drying up, the yolk which nourishes the growing chick, and the egg white which cushions the chick and provides additional nutrition. Locate the air sac in the flatter part of the shell which passes air from the outside to the chick.

Materials: Egg and pie plate.

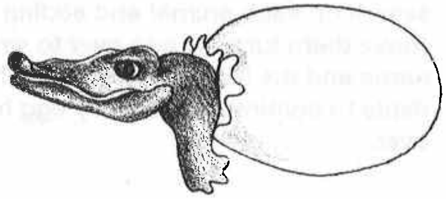
Q. Are the chicks alive before they hatch?
A. Yes, in fact you can hear them peeping in the shell for a day or so before they hatch.

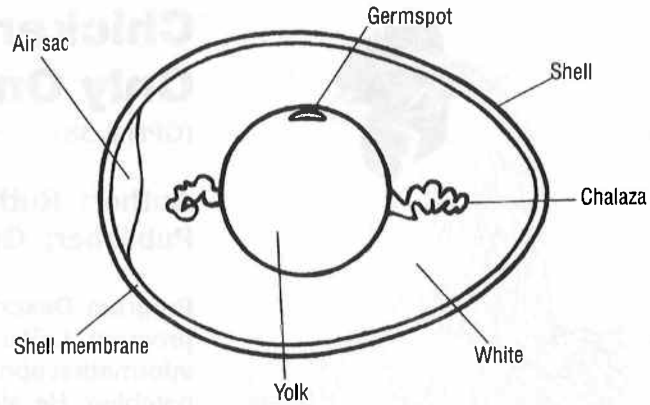
Q. Will the eggs bought in a grocery store hatch?
A. Supermarkets generally carry only unfertilized eggs, so they cannot hatch.

Q. If the chick is alive before it hatches, then how does it breathe?
A. The *membrane* that surrounds the chick allows gases to pass through, and the *shell* has small pores that let air in (if you look closely, you can see them).

Q. Why doesn't the *yolk* settle to one side when it is laid on its side for so long?
A. Structures called the *chalaza* (these are the white sting tissues connected to the *yolk*) extend through the long axis of the egg and connect to the *yolk*. This holds the *yolk* in place.

Q. How much of the egg is what becomes the chick?
A. On the *yolk* of a fertilized egg there is a darker disk about 1/8" (3 mm) across which is called the *germ spot*. This contains the nucleus, the beginning of the chick.





Hatchings

Key Words: *hatching, eggs, developing, embryo*

Concept: *Embryos change as they develop.*

Hatching snails is easy, cheap and dependable. They can be purchased at pet stores that handle aquatic and marine animals.*

Materials: Snails, 2 large glass containers, aquatic plants, limestone chips or plaster of paris, water.

1. Put snails and aquatic plants in a water-filled glass container and set it in a well-lighted spot. This environment will usually provide the snails with enough food; however, it is best to add a few limestone chips or a small amount of plaster of paris as a calcium supplement to insure proper shell development.

2. Watch for jelly-like egg masses that will usually attach to the plants or the side of the container. The adults may eat the eggs, so remove them to another container.

3. The developing embryos can be observed through the transparent eggs. The snail will hatch in 2-3 weeks. Hatchlings look like miniatures of the adults and can be fed small amounts of dry fish food.

* Brine shrimp (*Artemia saltina*) are another easily-hatched organism. They are available at the same outlets and usually come with everything needed for hatching, including instructions.

"Eggs-periments"

Key Words: *eggshells, calcium carbonate, carbon dioxide gas*

Concept: *Eggshells are made primarily of calcium carbonate.*

Eggshells are primarily made of calcium carbonate. The acid in vinegar can break down the calcium carbonate of the eggshells and cause carbon dioxide gas bubbles to form. These bubbles are made of the same gas as the bubbles in soda pop.

Materials: Paper towels, eggshells, baby food jars or small drinking glasses, white vinegar, water.

1. Rinse eggshells with water and dry them with a paper towel. Break them into pieces about 1/2" (1cm) in diameter.

2. Provide each student group with 2 glass containers — one with a small amount of vinegar, the other with a small amount of water — and a piece of shell.

3. Have them break the shell in half and put one half in the vinegar and the other half in water. (The shell in vinegar will release gas bubbles and will slowly begin to dissolve.)

4. After several hours, remove any remaining shells from the liquids, and compare the feel and strength of each. (The one in vinegar will be more brittle.)

Making "Eggs-act" Models

Key Words: *egg, fossil, dinosaur, hypothetical*

Concept: *There are limits to what is known about fossil eggs.*

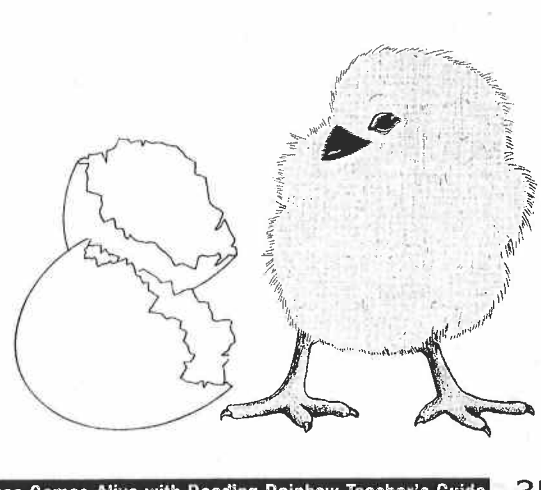
Dinosaurs laid eggs and scientists have been able to study these in fossilized form. In Mongolia, an entire nest of fossilized Protoceratops eggs were discovered. These elongated eggs are 8" (20cm) long and are longitudinally striated. Hypselosaurus eggs, found in southern France, are among the largest eggs ever discovered — 10" (25cm) in diameter and almost spherical.

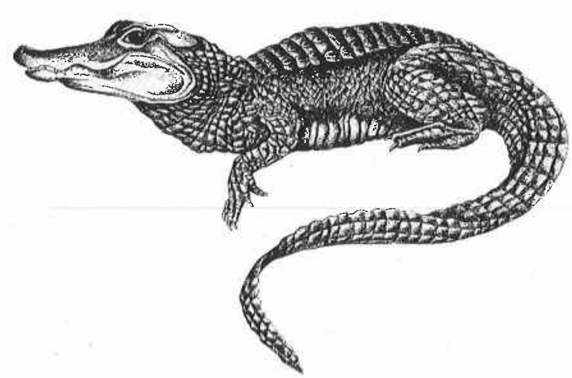
Materials: Papier-mâché makings: wheat paste or wheat flour, newspaper and water; balloons, paints.

1. Locate a dinosaur book or encyclopedia that has pictures of a variety of dinosaur eggs. After a class discussion about these eggs, make "eggs-act" or hypothetical models.

2. Have students blow up oval balloons to the size needed for their dinosaur egg model. Use papier-mâché to cover the balloon.

3. After the egg models are dry, paint them. Since our knowledge about dinosaur eggs is based on fossilized eggs which have lost their original color, students can use their imaginations.





Come A Tide

(GPN # 86)

Science Comes Alive
Science Focused

Author: George Ella Lyon
Illustrator: Stephen Gammell
Publisher: Orchard Books

Program Description: This story of one quirky family's adventure during a spring flood inspires LeVar's exploration of dramatic weather — from blizzards to tornadoes, and everything in between. Then a news reporter provides an eyewitness account of Hurricane Hugo and the courageous people who weathered the storm.

A Storm Of Applause

Key Words: sound, rainstorm

Concept: Natural events can be observed with different senses.

Imagine a rainstorm. How does it look, feel, smell, sound? Try creating/imitating the sounds of a rainstorm.

Materials: Thin metal cookie sheet or large piece of poster board, plant mister

1. Demonstrate the following hand sounds using an irregular rhythm to simulate raindrops.

- Rub your palms together in a circular motion — to create the sound of wind and light drizzle.
- Then firmly tap your index fingers together like rhythm sticks — to create the sound of large drops.
- After several seconds, tap two fingers on each hand together (again like rhythm sticks), then three, then start to clap your hands together very lightly, then harder and harder — to create the sound of heavier rain.
- Move backwards through the sequence (keeping the rhythm random) — to create the illusion of rain tapering off and stopping.

2. Turn down the lights, so it seems like a cloudy day. Have students make each sound with you, switching to new sounds as you do. With the whole class participating it will sound like a rainstorm that starts with a drizzle, builds to a downpour, then tapers off to a drizzle and finally stops. (Simulate thunder by holding the corner of a large piece of poster board or a thin metal cookie sheet and shaking it.)

3. Repeat Step 2 and have students close their eyes to imagine the storm. Use a plant mister to spray a few drops of water into the air for a surprise ending.

Water, You Trying To Measure?

Key Words: *rain gauge, measure, accurate*

Concept: *Rainfall amounts can be measured more or less accurately using different devices.*

Here are some pointers that will help in making an accurate rain gauge:

- **Use a container that is at least three inches wide.** A gauge that is too narrow may be inaccurate because of turbulence caused by wind blowing across the opening.
- **Use a container that has straight sides.** A bucket with a wide mouth and slanting sides exaggerates the amount of rainfall. A straight-sided coffee can works well.
- **Use a container that has a flat bottom.** Some containers have indentations at the bottom that take up volume and make the depth seem greater than it really is.
- **Put the container on a stake 3-4 feet off the ground in a clear area.** Breezes that blow at ground level or around objects, like tables or fences, can change the amount of rain that falls in a particular area.
- **Read the gauge right after each rain.** As soon as the rain stops, water begins to evaporate. To create a gauge that slows evaporation, find a funnel that has a top opening the same size as your gauge. Then use clay or tape to seal the funnel to the container.
- **Use a ruler to measure the depth of the water.** Place a ruler flat against the inside of the gauge and rest it on the bottom to measure the water level.

Dropper Spotters

Key Words: *size, comparing, drop*

Concept: *The size of water drops can be compared.*

Are all raindrops the same size? Find out by comparing the sizes of flattened drops.

Materials: Cardboard boxes (e.g. from cereal or crackers), water, medicine droppers, hand lenses, toothpicks, spoons, ruler

1. Cut the cardboard boxes so they can lay flat with the inner, unfinished side facing up.

2. Use a medicine dropper to make "raindrops" fall onto the cardboard.

3. Examine the drop spots on the cardboard using a hand lens. Are they all the same shape? What do they look like at the edges? Why do you think they look the way they do?

4. Are all the drop spots the same size? Measure the width of the spots with a ruler. How big is the largest? How small is the smallest?

5. Use the toothpick, spoons or other objects to make drops fall on the cardboard. Compare the spots they make to the spots made with the medicine dropper. Does changing the distance the water falls make any difference in the spots?

6. The next time there is a gentle rain outside, place a piece of cardboard on a flat surface where raindrops can fall on it for several minutes. After retrieving it, look to see if all the raindrop spots are the same. How do they compare with the "class-made" spots?

Spitter Spatter Patterns

Key Words: raindrops, pattern

Concept: The arrangement in which raindrops fall can be observed and checked for patterns.

Do drops fall in the same place over and over? Do they fall in a regular pattern?

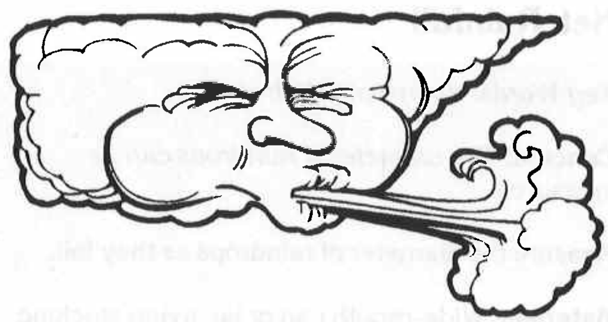
Materials: Paper, watercolor paints, brushes, scissors

1. Have each student use watercolors in a variety of deep primary colors to paint big, solid shapes (e.g. circles, squares, triangles) on a large sheet of paper. Allow the paintings to dry.

2. When it begins to rain, lay the paintings on a flat surface and let them be rained on briefly. The drops will dissolve the paint and splash the colors around the paper. (Droppers can be used to simulate rain, although no conclusions could be made about the pattern of raindrops.)

3. Allow the pictures to dry. What can the students tell about the patterns of drops? (*Most likely the patterns are random, hitting about evenly across the page.*)

4. To examine the pattern of the raindrops more closely, have students create a template by cutting a 2"x2" square hole in the center of a piece of paper. Place the template over an area of rain-splashed paper and count the drops visible in the 2"x2" cutout hole. Move the template to another area and do it again. After checking several more areas, compare the results.



What's Moist Important

Key Words: humidity, weather, dew point, temperature, clouds, condense

Concept: Humidity is an important factor in weather.

An important element of weather is humidity — the moisture in the air. Warm air holds more moisture than cool air. As air cools condensation occurs — forming clouds and perhaps even rain. The temperature at which water condenses from the air is called the *dew point.*

See **Jack, The Seal And The Sea** for several humidity related activities and, to get a fairly good measurement of the dew point, do this adaptation of the ***No Sweat*** activity.

Materials: Shiny metal can (or other smooth container), water, ice, thermometer

1. Fill a smooth container half full of room temperature water. Put ice in the water and stir.

2. Place a thermometer in the water. Watch the outside of the container for the first signs of moisture, and note the temperature when moisture appears. This is the dew point.

3. How much would the temperature of the room have to fall before moisture started to condense on surfaces in the room? (*room temperature minus dew point*)

Clouds usually form high in the sky — what can we infer about the air temperature where they form? (*It is cooler and the temperature is equal to or below the dew point.)*

Net Rainfall

Key Words: *diameter, raindrop*

Concept: *The diameter of raindrops can be measured.*

Measure the diameter of raindrops as they fall.

Materials: Wide-mouth can or jar, nylon stocking, powdered sugar, medicine dropper

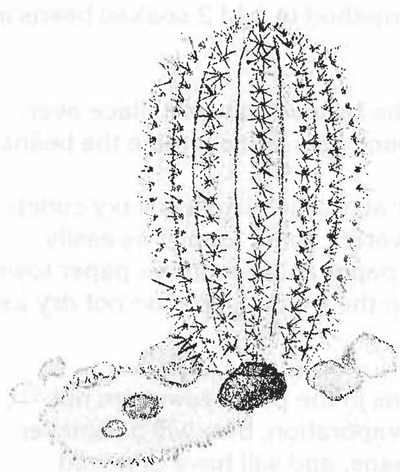
1. Cover a can with a nylon stocking. The nylon should be taut but not stretched.

2. Sprinkle powdered sugar in a thin layer across the nylon.

3. Use a medicine dropper to simulate raindrops or hold the can in the rain until a few drops fall on it. As the drops pass through the sugar, they will dissolve it and clear an area the same width as they are. These widths can be measured and compared to the sizes of the drop spots in the *Dropper Spotters* activity. Why might there be differences?

Science Comes Alive

Science Focused



Desert Giant:

The World Of The Saguaro Cactus

(GPN # 62)

Author: Barbara Bash
Publisher: Sierra Club Books

Program Description: The Sonoran Desert in Arizona is the home of the saguaro (sa-WAHR-oh) cactus. In this program, LeVar travels to the southwest, where he learns more about these majestic desert plants, and meets some of the desert's noted animal inhabitants including a bobcat, Gila monster and javelina pig. He also introduces us to a real life "snake man" who milks rattlesnakes.

A Slice Of Desert Life

Key Words: desert, pleat, absorb, expand, measurement, estimation

Concept: *The pleated shape of many cacti allow them to expand as they absorb water.*

Deserts are places that have less than 10" (25cm) of precipitation a year. When it rains or snows in the desert, moisture is plentiful for only a short period of time. Between these wet times are long dry periods. Saguaro cacti live through these dry times by storing water in their trunks.

Because the trunk of a saguaro cactus is pleated, it can expand as water is absorbed, and contract as water is used. Examine how the pleats of a cactus work well for adjusting to volume changes and practice measurement and estimation skills.

Materials: Green paper, glue, grid paper, pencils.

1. Use a strip of green paper about 24" (61cm) long x 1" (2.5cm) wide. Mark lines at 1" intervals along the length of the paper.

2. Fold the paper back and forth, accordion style, along the lines. Join the ends of the paper to make a pleated loop. This is a simple model of a cross-section of a saguaro trunk.

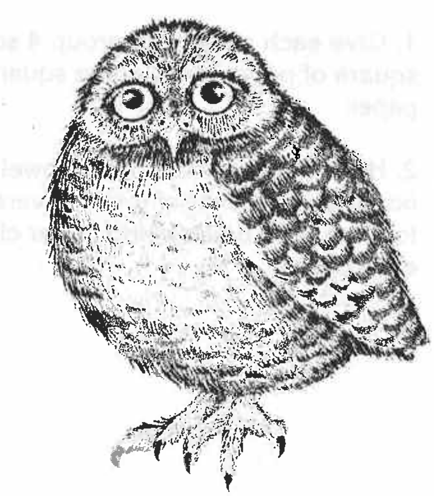
3. To measure the cross-sectional area, lay the model on a piece of grid paper with fairly wide (at least 1/2" or 1cm) grid lines. Estimate how many squares fit inside the loop.

4. Improve this estimate by drawing around the pleated loop and counting how many squares are in it.

5. Expand the loop by pushing against it from the inside. This expansion is similar to what happens when the saguaro has absorbed water. Estimate how many squares fit in the expanded loop.

6. Compare estimates. Discuss why some estimates are higher or lower than others. How many more squares fit inside the expanded loop than in the unexpanded loop? How does this relate to the saguaro?

Science Note: The internal volume of a saguaro cactus can be estimated by multiplying the cross-sectional area by the height of the cactus. (Not all of that volume is water.) Saguaros usually have a trunk diameter of 1-2 1/2'. The tallest saguaro ever found was 58' 11 3/4".



Saguaro Noodles

Key Words: pleat, water, absorb

Concept: Plants respond to their environment, as can be seen when a cactus absorbs water and the pleats on its surface become less pronounced.

If the weather has been dry for awhile, a saguaro cactus has less water stored and the pleats of the cactus are deeper and more visible. When it rains, or water is available, the trunk fills with water and the pleats become less pronounced.

Materials: Large rigatoni noodles, baking pan, water.

1. Stand a few noodles in a pan of water. The water level should reach halfway up the noodles.

2. Examine the noodles after 3-4 hours when they have absorbed some of the water. The walls will be thickened and the pleats will be less pronounced than on the dry ends of the pasta.

Holding It All In

Key Words: cuticle, evaporation

Concept: Many desert plants have a thick, waxy cuticle layer on their surface that helps slow evaporation through their skin.

Saguaros, like all cacti, are covered with a thick, waxy coat. This coat, or cuticle layer, helps reduce the amount of water that is lost by evaporation.

Materials: Soaked beans, 2" (5cm) square pieces of paper towel, 2" (5cm) square pieces of waxed paper, paper clips.

1. Give each student or group 4 soaked beans, a square of paper towel and a square of waxed paper.

2. Have them fold the paper towel over 2 soaked beans so one layer of towel covers the beans; then fold the ends under using paper clips to fasten the ends tightly.

3. Use the same method to fold 2 soaked beans in the waxed paper.

4. After leaving the beans in a warm place overnight, open the packages and examine the beans.

The waxed paper acts much like the waxy cuticle of the cactus — water cannot escape as easily through the wax paper as through the paper towel — so the beans in the waxed paper do not dry as quickly.

Because the beans in the paper towel are not protected from evaporation, they will be smaller than the other beans, and will have dry seed coats.

Thirsty Beans

Key Words: seed, imbibition, germinate

Concept: Seeds take in water in a process called imbibition, which can trigger germination in some plants.

Most seeds take in water through a process called imbibition. Imbibition can cause the seed to swell — sometimes this triggers seeds to germinate. For desert plants, like the saguaro (whose seeds are the size of a pinhead), it is important that seeds germinate when water is available.

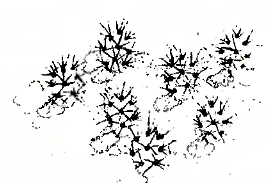
Materials: Dry lima beans, pencils, paper, ruler (optional), water, paper cup, paper towels.

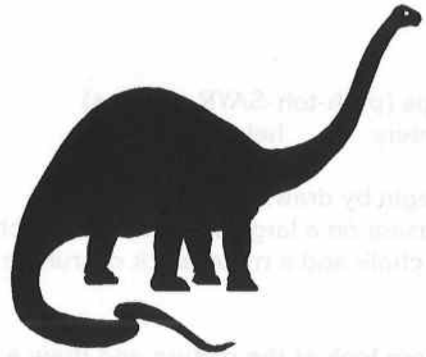
1. Number several large lima beans with a pencil and record their presoaked size by tracing their shape or by taking measurements.

2. Soak the beans in water for several hours or overnight.

3. Pat the beans dry with paper towels and compare them to their dry size and shape.

The beans will expand with the extra water. For many beans, the outer layer (seed coat) will tear as the two fleshy inner parts (cotyledons) expand. The saguaro's trunk coat would split as it took in water if it were not for the pleats.





Science Connected

Digging Up Dinosaurs

(GPN #6)

Author: Aliki
Publisher: HarperCollins

Program Description: LeVar explores the fascination of dinosaurs who lived, and then disappeared, millions of years ago when he visits Utah's Dinosaur National Monument where a park ranger and paleontologist take him on a fossil tour.

Dino-Mite Bones

Key Words: dinosaurs, fossils, excavation, paleontologist

Concept: Fossils of dinosaur bones can be removed from rock.

When LeVar visited Dinosaur National Monument, he saw a paleontologist excavating fossilized dinosaur bones from a rock cliff full of bones. Be a paleontologist and dig up some bones.

Materials: 1/2 pint milk cartons, plaster of Paris, water, sand, dog biscuits in the shape of bones (different colored biscuits work well), newspapers, paper and pencils, tools for carving in the plaster such as spoons, table knives, metal nail files, toothpicks, toothbrushes.

1. Cut the tops off clean milk cartons so they are about 2" tall.

2. Mix up plaster of Paris adding one cup of sand for each cup of powdered plaster to make the dried plaster less solid. Pour about 1" of the wet mixture into each carton. Let the plaster set-up briefly (just a minute or so), then partially insert a biscuit into the plaster of each carton.

3. When the plaster is dry, give each student paleontologist a carton with a bone. (For younger students have the plaster slightly damp so it will be easier to work with.) Before beginning, have students make a drawing to record how their bone is positioned in the plaster. Have them make a second drawing showing what they think their excavated bone will look like.

4. After they cover their work area with newspaper, have them begin excavating their bone using their tools safely and carefully.

5. When they have finished excavating their bone, ask them to examine it carefully. Have them draw a picture of the bone, noting any places where it was broken or damaged during excavation.

Big, Really Big

Key Words: *dinosaurs, size, measurement*

Concept: *Some dinosaurs were very large, but others were small.*

The largest land animals that ever lived were dinosaurs, but not all of them were big. Some were only the size of a chicken. Compare the size of big and small dinosaurs.

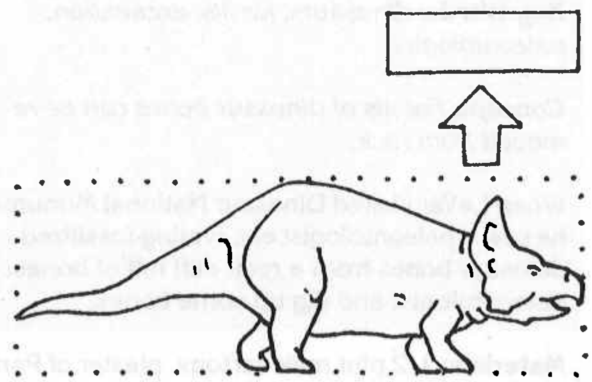
Materials: Large area (such as a concrete playground or outside basketball court) that can be drawn on with chalk, chalk, meter sticks, trundle wheel (optional).

1. Give each small group of students the dimensions and a picture of one of the following dinosaurs:

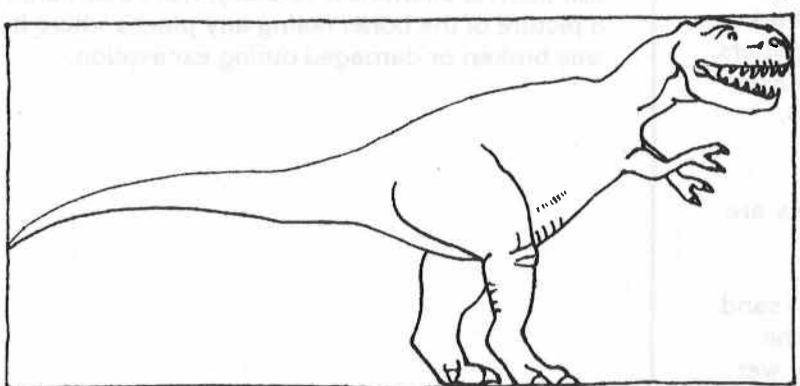
- Apatosaurus (uh-PAT-oh-sor-uss)
  length: 21 meters   height: 5 meters
- Tyrannosaurus (ty-ran-oh-SOR-uss)
  length: 13 meters   height: 6 meters
- Stegosaurus (steg-oh-SOR-uss)
  length: 8 meters   height: 4 meters
- Protoceratops (proh-toh-SAYR-uh-tops)
  length: 3 meters   height: 1 meter

2. Have them begin by drawing a rectangle the size of their dinosaur on a large cement area. Each group will need chalk and a meter stick or trundle wheel.

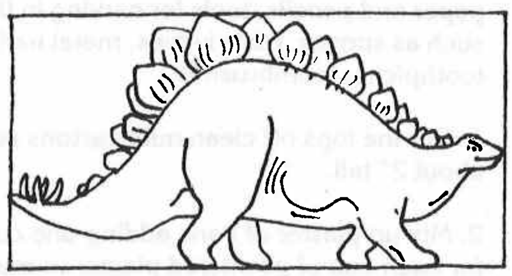
3. Then have them look at the picture and draw a life size outline of their dinosaur in the rectangle. Remind them to draw the dinosaurs as big or small as the rectangle, and to write the name of the dinosaur below their drawing.



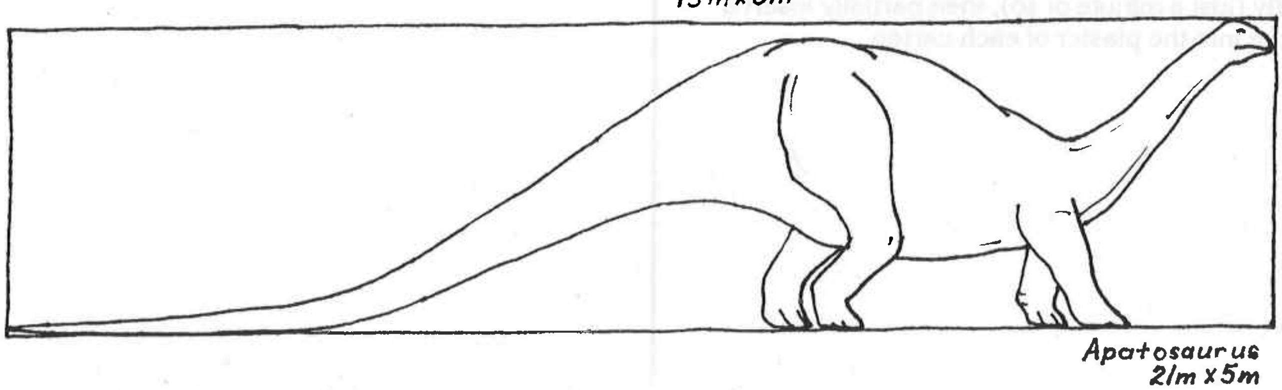
Protoceratops
3m x 1m



Tyrannosaurus
13m x 6m



Stegosaurus
8mx4m



Apatosaurus
21m x 5m